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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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The Government of Victoria does not bind itself to accept the lowest or any tender.

PETER McBRIDE,
Agent-General for Victoria. O 124

THE COMMISSIONERS OF HIS MAJESTY'S WORKS, &c., are prepared to receive

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No application forms.

S. OLDROYD,
Secretary.

Education Offices,
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Manager Required for Small Steel Foundry in Hong Kong, which is being enlarged and reorganised. Applicants must be able to advise and superintend the laying out of modern steel foundries, including crucible, electric and open hearth furnaces. Applications from suitable discharged men would be considered.—Apply, stating age, experience, qualifications, salary required, references, &c., to BOX 759, care of Leathwaite & Simmons, 5, Birchin Lane, E.C. 3. M 718

Wanted, by Large Seed Crushers on the Thames, WORKS MANAGER, for preference a Chemical Engineer. Applicant must have thorough allround training and experience. Good and progressive position for competent man.—Address, O 93, Offices of Engineering.

Secretary Wanted, by a Firm of Engineers and Founders (Limited Co.) in the Midlands. Must be able to supervise finance, cost and secretarial departments. Chartered accountant preferred. State experience, age and salary required.—Address, M 966, Offices of Engineering.

Estimating Clerk Wanted, for large works in the Midlands, producing wrought and cast ironwork. Permanent situation. Practical works knowledge and previous experience in costing essential. No person already employed on Government work will be engaged.—Apply, stating full particulars and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 5787. O 99

Research Chemist Wanted, knowledge of organic chemistry and experience in general metallurgical analysis essential. No one at present engaged on Government work need apply—Apply, stating age, experience, and salary required to your nearest EMPLOYMENT EXCHANGE, quoting No. A 6131. M 997

Deputy Stores Superintendent Required for 3 years' service on the Federated Malay States Railways with possible extension. Should have a general knowledge of stores and storekeeping (railway stock-keeping preferred), including buying, examination, storing, accounting and auditing, and be capable of taking charge of the Stores Department when required. Age not to exceed 35 years, preferably unmarried; loss of an eye or the left arm not a disqualification. Salary £380-£15-£500, with a duty allowance of £80 a year. Free passages.

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Wanted Assistant Chemist with experience in the analysis of iron, steel, and non-ferrous alloys, for large works in the North of England. No one at present engaged on Government work need apply. Write stating age, experience and wage required to nearest EMPLOYMENT EXCHANGE, quoting No. A 6182. O 146

Leading Firm of Brass Founders, Finishers, and Coppersmiths, on the North East Coast, are seeking a Capable WORKS MANAGER. Apply giving full particulars and salary desired. A good permanent post can be offered to a thoroughly capable man who can handle the whole product of the Company. Address, O 163, Offices of Engineering.

Experimentalist Required, to take charge of small development department in an Electrical Switch-gear Works. Good theoretical knowledge necessary. No person already employed on Government work will be engaged.—Apply, giving full particulars and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 6079. O 94

An Experienced Man Wanted, to control Inspection department in Aircraft works in Eastern Counties. A man with wide experience in a similar position required with a sound judgment and education. No one already on Government work need apply. — Applicants to state salary expected, experience and when could commence, to nearest EMPLOYMENT EXCHANGE, mentioning this paper and O 128.

Blast Furnace Manager WANTED, for South Wales district.—State experience, salary required and full particulars.—Address, O 137, Offices of Engineering.

Engineer Wanted, to take charge of repairs and maintenance on a Chemical Works in London Applications will only be considered from men discharged H.M. Forces after active service.—Address, stating age, qualifications, experience, etc., M 925, Offices of Engineering.

Assistant Engineer Required, by large firm of Internal Combustion Engine Manufacturers. Must have had a good technical and practical education Preference given to one with experience in the design of high compression marine oil engines. No one on Government work need apply. State age, full details of experience, salary required and when at liberty to commence.—Apply, your nearest EMPLOYMENT EXCHANGE, quoting No. A 6161. O 41

Engineer Required for Chemical Works to supervise the construction and erection of chemical plant and power plant, &c., must be thoroughly competent man, having good organising and controlling abilities.—Address, giving full particulars, stating age and salary required, O 127, Offices of Engineering.

Engineer Examiner Wanted for checking machine parts. Must have served apprenticeship in the trade, able to use vernier and micrometers and understand drawings. Will be attached to drawing office of large works near Woolwich. State age, experience and salary required.—Address, O 141, Offices of Engineering.

Required, by Technical Dept. of large Export House, in connection with the reconstruction of Russian trade, English ENGINEERS, with knowledge of Russia and the Russian language.—Write, stating age, experience and salary required, to ENGINEER, care of Street's, 30, Cornhill, E.C. 3. O 153

Small Tools Engineer.—WANTED, a capable man with Engineering ability and thorough knowledge of this branch of Machine Tools, to TAKE up POSITION in Engineering firm in the East, either immediately or after the War. Candidates must be British, and preferably unmarried.—Full details, stating salary expected, to No. 3460, care of Dawson's Advertising Agency, 121, Cannon Street, London, E.C. 4. O 167

Required Immediately the SERVICES of a capable COMMERCIAL ENGINEER, with a thorough knowledge of portable railway material. Good salary and prospects to the right man. Apply with full particulars of past experience and present employment to BOX No. 696, care of Dawson's Advertising Agency, 121, Cannon Street, London, E.C. 4. O 168

Wanted, Qualified Electrical ENGINEER with good mechanical knowledge, for consulting engineer's office chiefly dealing with Iron, Steel, and Mining work. State age, experience, and salary.—Address, O 158, Offices of Engineering.

Opportunity Offers for a good progressive post as Publicity Man in office of well known firm of Machine Tool Manufacturers, ex-officer, University man, with some knowledge of mechanics preferred. No one already employed on Government work will be engaged. Write stating experience and salary required to your nearest EMPLOYMENT EXCHANGE, mentioning No. O 117. O 117

First-class Draughtsman REQUIRED, accustomed to Diesel or Semi-Diesel Engines, for large Engineering Works, Manchester district. No one on Government work will be engaged.—Apply, stating age, experience, and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 6160. O 40

Draughtsmen Wanted for urgent Government work by crane makers in Manchester district. Applications invited from good mechanical and structural men. Crane experience not essential. State age, salary and experience. No one on Government work will be engaged. —Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 148.

Crane Draughtsmen Wanted, or men used to designing and detailing special structures. State age and salary required. No one already employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 2.

Plant Draughtsman Required for engineering works in Yorkshire. no one already employed on Government work need apply. —Applicants should state full details of experience and wages required to their nearest EMPLOYMENT EXCHANGE, quoting No. A 6155. O 74

Tool and Plant Draughtsmen REQUIRED for urgent Aero and Motor work in progressive Midland works. Permanencies for live, interested, quick men with initiative and ability. No person already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning No. 5316. M 610

Wanted, Capable and Live DRAUGHTSMAN as Standardizer, must have initiative, resource, and knowledge of design for rapid and accurate engine production. State age, experience, and salary required. No one on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, quoting No. A 6166. O 72

Draughtsmen Wanted, having had first-class experience in general Engineering. Establishment is controlled and the position is permanent to suitable man. No person already on Government work will be engaged.—Apply, stating full particulars to your nearest EMPLOYMENT EXCHANGE, mentioning A 6142. O 90

Wanted, Thoroughly Qualified Mechanical DRAUGHTSMAN or Engineer. One having experience in Small Arms work preferred. — Apply by letter, ADMIRAL SLADE, 92, Victoria Street, S.W. 1. O 100

Draughtsman Wanted, by Controlled Establishment in West Riding of Yorkshire. One with experience in design of motor vehicles.

Also a good JUNIOR DRAUGHTSMAN.

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Draughtsman (Mechanical) WANTED, by Railway Company in London, with knowledge of Electric Signal Interlocking Preferred. State age and experience.—Address, O 123, Offices of Engineering.

Draughtsman.—Wanted, by large electrical engineering firm in S.E. London, experienced MAN, must have had shop training, neat, quick and accurate. No one at present employed on Government work will be engaged.—Apply, stating age, experience and salary required, to nearest EMPLOYMENT EXCHANGE, mentioning Engineering and O 156.

Draughtsmen Required, Ex- perienced on medium or heavy Machine Tools, also one accustomed to Jigs, for Controlled works. Permanency to suitable men. No person already on Government work will be engaged.—Apply, stating full particulars, to your nearest EMPLOYMENT EXCHANGE, mentioning A 6143. O 91

Wanted.—Product Dept. of a large aircraft factory in London requires a good MAN to assist in the planning of contracts. A thorough knowledge of up-to-date machine shop methods and time fixing for all metal parts for aircraft is essential. No one already employed on Government work, or resident more than 10 miles away, will be engaged.—Address, O 170, Offices of Engineering.

Wanted, by Large Aero- nautical Firm in the N.W. London district, DRAUGHTSMAN for scheduling work, previous knowledge in aeronautical work not essential. No one already employed on Government work or resident more than 10 miles away will be engaged.—Apply, stating age, experience, and salary required, to BOX R.M. 7, care of W. H. Smith & Son, 55, Fetter Lane, E.C. 4. O 145

Wanted at Once, a Thor- oughly capable DRAUGHTSMAN with large and varied experience in Electric Crane design to undertake standardisation work. Good salary and prospects for the right man. State age, experience and salary required. No one already on Government work will be engaged. — Apply, your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 149.

Draughtsman.—A Firm of Chartered Patent Agents have a permanent POSITION VACANT for a good DRAUGHTSMAN who has had previous experience with patent drawings. Reply stating age, qualifications, experience and salary required to BOX 14, Sells, Ltd., 168, Fleet Street, E.C. 4. O 171

Wanted, Experienced DRAUGHTSMAN, for large Engineering Works, Manchester district, used to general maintenance work, lay out of plant, buildings, &c., also general repair of machines. No one already on Government work will be engaged. State age, experience and salary required.—Apply, your nearest EMPLOYMENT EXCHANGE, quoting No. A 5826. M 967

Draughtsman.—Wanted, an Experienced DRAUGHTSMAN for a Machine Tool Works specialising in Lathes. Knowledge of jig design a recommendation. Permanent situation for a good man. No one already employed on Government work will be engaged.—Apply, giving full particulars of experience, age, and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and M 360.

Appointment Open in London factory. Staff position. Good salary. DRAUGHTSMAN, with sound mechanical engineering knowledge and training. No one at present on Government work or residing more than 10 miles away need apply.—Address, O 130, Offices of Engineering.

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Applicant must have had some workshop experience and sound technical training.

Apply, giving full particulars of experience and training, state also age, salary required, and when at liberty, to O 120, Offices of Engineering.

Junior Draughtsman Required. One with workshop experience on production of heavy commercial vehicles, to train as jig and tool designer. Excellent opportunity for an ambitious young man. No one already on Government work, or resident more than 10 miles away, will be engaged.—Apply, Mr. COOK, Klaxon Co., 38, Blandford Street, W. O 173

Required, for Aeroplane Factory in N.W. London, MAN to assist in planning, fixing layouts and operations on jobs passing through shops. No one already on Government work, or resident more than 10 miles away, will be engaged.—Reply, giving full particulars as to salary, &c., to BOX 981, Sells Ltd., 168, Fleet Street, E.C. 4. O 121

Turner Wanted, for Small general Engineering Works in London engaged on important work. No one at present employed on Government work or resident more than 10 miles distant need apply.—State full particulars and wages required. — Address, O 161, Offices of Engineering.

Two Jig & Tool Draughtsmen REQUIRED for Controlled firm in N.W London district. Shop experience essential. No person engaged on Government work or residing over 10 miles away need apply. Applicants state experience and salary required,—Address, O 140, Offices of Engineering.

Lathe Turners Required at once for London works. No one engaged on Government work, or living more than 10 miles away need apply.—Write, in first instance, stating experience and wages required, to Z.H. 822, care of Deacon's, Leadenhall Street, E.C. 3. O 164

Foreman, Electrical Control Gear, WANTED by large electrical firm in Manchester district, a first-class practical man to take charge of department on heavy control gear for steel works, etc. Only those with successful record in similar capacity need apply. No one already engaged on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, stating age, experience in full, and salary required, mentioning No. A. 6186. O 111

Works Foreman Wanted, for small Aircraft Factory, engaged principally on Turnbuckles. Must be well up in capstan work, good organiser and Six o'clock man. State age and wages required. Only first-class men need apply. No person already on Government work will be engaged.— Apply your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and O 107.

Wanted, Foreman for Machine Shop and Tool Room in Midlands employing 100 hands, manufacturing precision aeroplane parts, experience of tool room rate fixing essential, permanent position for energetic man. No person already employed on Government work will be engaged.— Apply your nearest EMPLOYMENT EXCHANGE, mentioning No. A 6187. O 113

Three Locomotive Foremen AND ONE ASSISTANT BOILER SHOP FOREMAN REQUIRED for the Federated Malay States Railways, for three years service with possible extension. Age not to exceed 35 years, preferably unmarried; the loss of an eye or of a left arm not a disqualification.

Salary £280-£10-£350, with a duty allowance of £50 a year. Free passages.

The Locomotive Foremen must be fitters by trade preferably with running shed experience both as regards running and repairs of locomotives. Will be required to take charge of a Locomotive Shed and District, including all locomotives and machinery as regards maintenance and repairs, and also the charge of all locomotive working and staff in the District under the District Locomotive Officer.

The Assistant Boiler Shop Foreman must have served his time as boiler maker in an approved shop and subsequently as journeyman. Preference will be given to a man well up in repair work. Must be well versed in modern practice both in construction and the use of compressed air and hydraulic tools. Experience as an Inspector would be valuable.

Candidates should apply to their nearest EMPLOYMENT EXCHANGE, giving full particulars of training and experience, quoting No. A 5130 and mentioning this paper. No person engaged on Government work or eligible for the Army need apply. O 151

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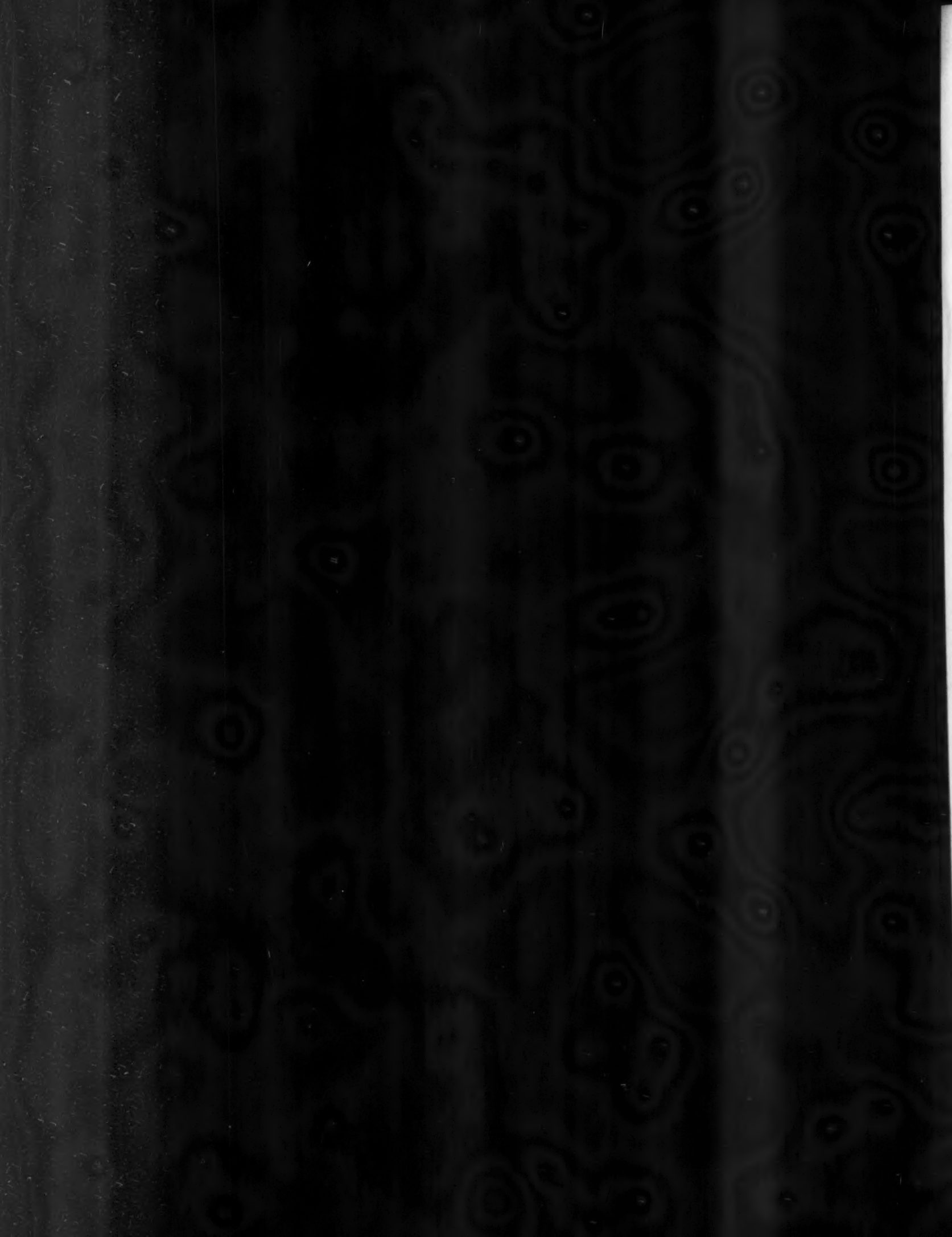


THE WORKER, THE EMPLOYER, AND THE UNSOLVED PROBLEM.

By Alex. Ramsay.

The fundamental problems, and those which from time to time arise, in connection with the relation of the worker to the employer, create an amount of discussion which indicates how fully our national interests are bound up with the question, and the anxiety with which it is contemplated by those who have an intelligent regard for the welfare of the country. At the same time there is a disposition in certain quarters to view the problem with some impatience, regarding it as one about which too much has already been said, on the apparent assumption that discussion tends to magnify the issues and that they will become less dangerous if ignored.

It is no doubt true that there is a risk of the practical issue being smothered in the verbiage of sentimental theorists, political propagandists, and economic doctrinaires; but it is equally true that an acute and pressing problem does exist; that the practical minds from whom only a satisfactory solution can be hoped have given it very little real attention; and that impractical suggestion on the one hand is less to be condemned than sterility of idea on the other. It were well that we should realise before it is too late that the greatest of our industrial problems, and one of the greatest of our national problems, cannot be lightly dismissed or conveniently laid aside without grave prejudice to the future of the economic interests which are the foundation and being of our country's strength. On the contrary, the necessity is more pressing than ever that men with well-balanced minds and an intimate knowledge of industrial and commercial conditions should make a practical study of the ground upon which Capital and Labour stand, in order that the development of their joint relations may be made on an understandable basis, instead of being—as heretofore—subject only to the drift of blind and unreasoning forces.

Whether we like it or not, we are faced with the amazing position that the two most important sections of the community, each contributing a function necessary to the other and upon the joint activities of which the prosperity of the nation depends, are organising themselves, conserving and developing their strength for the express purpose of fighting one another, at the same time realising clearly that such an eventuality would be a disastrous one for all concerned and involve losses from which the country could not easily recover. If the worker and the employer had come to the studied conclusion that only force could settle their differences the existing position could be more easily understood, but believing as they are bound to do, that prolonged economic strife would be disastrous to our industrial interests, we are forced to the opinion that the labour outlook—chaotic, uncertain, threatening—is much more apparently hopeless and menacing than it need be, did we give the problem a tithe of the clear-minded, disinterested attention it demands.

We shall do ourselves and the country a service if we face the facts. The workers are suspicious and difficult to lead, sometimes unreasonable, extremely jealous of their rights and privileges, determined to wrest from industry every advantage they can obtain without any apparent consideration to the possible economic results. Their leaders are damaging their case by overstating it and creating opposition to even reasonable progress by propagating the doctrine of workshop domination and the control of industry, at a time, too, when they are unable to control the members of their own organisations. We find them in congress and on political platforms formulating demands which, if granted in our present state of inefficient production, would utterly destroy our position as a manufacturing and exporting community. We find them, in short, demanding more than industry is yet able to give, and seeking responsibilities which frankly they are not yet able to carry.

The employers, on the other hand—if the attitude of some of their associations may be taken as a guide—do not appear to have any progressive idea or intention. They apparently intend to marshall and exercise their immense power of resistance and to sit tight in their economic fastnesses until they are driven forth—if needs must be—by the sweeping development of working class political and economic influence. They are so accustomed to regard themselves as objects of attack that they seem content to adopt as a settled policy the attitude of passive reaction, on the principle that aspiration divided by opposition will somehow, sometime, give a fairly just and satisfactory result. Fateful issues surely, to be settled on the wheels of chance! Their only recognisable idea of building up a fund with which to fight is really pathetically inadequate, for if the occasion ever arose the chances are that they would never be able to use it. No Government of whatever complexion could tolerate for any length of time a general strike or lock-out which would inevitably bring the country to a state bordering on civil war, and in such event the employers would find, apart altogether from the merits of the dispute, that an overwhelming pressure would be put upon them to give such terms as would effect a settlement.

Now it is quite clear that more sensible relations cannot be attained until the points of difference are thoroughly investigated and understood, and the main desire in the present article is to appeal to the individual employer to make the problem his own and really study it. Opinions are of no use; loose thinking is valueless; the subject requires the same research and scientific analysis which are given to other manufacturing considerations of less importance. And it will pay! The works manager who knows his job, does not ignore the possible causes of trouble until trouble actually arises, he obviates friction by intelligent foresight. If his men have a legitimate grievance he removes it before an explosion occurs. If, on the other hand, they take a line which is detrimental to discipline or efficiency he never lets the issue rest until he has recovered the position. He realises, in fact, how much of his success as a producer depends upon the disposition of his workers and he regulates his action accordingly. What is true in this local sense is equally true in a national.

Until now the employer has been content to leave his national interests and responsibilities in the hands of a small executive which, however capable, cannot be said to concentrate the brains and statesmanship of a huge industry, and there is not the least doubt that the industrial outlook would become considerably clearer if he gave the labour issue his personal study and exercised his personal influence towards a solution.

Employers naturally cannot be expected to completely control Labour, but they can do much to educate and influence it if they will, and in this connection there are at the moment two primary questions which they should consider, namely, what can be done to safeguard their interests against unreasonable attack, and what can be done to provide for and direct the reasonable, necessary, and unquestionably certain advancement of the status of the worker. They need most urgently a clearly reasoned, well-defined, and actively pursued progressive policy which ought to be administered by their Federation, and should embrace certain considerations we shall proceed to discuss.

There are certain commercial factors, competitive, financial and others, which give those who look ahead, some cause for anxiety. It is unnecessary to capitulate that which is well known, but the general result is that the employer does not contemplate with any degree of satisfaction, uncompensated additions to his cost of production. The qualification "uncompensated" is an important one and should be used as a challenge to the honesty of the Labour movement. A study of the constantly reiterated aims of the trades unions and a fairly intimate knowlege of the individual mind, convinces one that the mass of Labour think only in terms of wealth distribution and pay not the least heed to the necessity of improving the means of wealth production. They act as if our economic prosperity were unchallengeable, whereas, as an actual fact, it is only maintained by the most anxious study, incessant energy, and wise foresight of those who control our manufacturing facilities. The worker appears to regard industry as a machine in perpetual motion, which delivers wages here and profits there. He is possessed by, and unfortunately limits his conception to the idea that he must reconstruct the channels of delivery and ensure that a larger proportion of the production goes to wages and a less to profit, ignoring altogether the elemental and vital fact that the output of the machine is definitely controlled by specific agencies of which he himself is one of the most important; that the total production, by his own choice, can be disastrously diminished on the one hand, or materially increased on the other. If the workers do not acknowledge this truth and all that it implies, the successful prosecution of their demands will only result in the bleeding of industry to a point of national danger, for it is obvious that the prosperity of an industrial people is bound up in the prosperity of its industries.

Now if all this be true, as it undoubtedly is, why do not the employers as a class make some endeavour to educate public—which includes Labour—opinion to the evil of such dangerous conclusion? We have seen a remarkable example of the way in which the authorities have influenced the views, maintained and stiffened the war *morale* of the people by a judicious use of the press and other agencies; and when the minds of the workers are being consistently poisoned by false economics, plausibly dressed, it is suicidal for the employer to stand calmly by as if the circumstances were to him one of no importance. We need sound and extensive propaganda, an emphasis of economic truths which will bring the nation to realise that industrial prosperity is the product of wise and energetic application, and that those things which we desire and call wealth have to be created before they can be enjoyed. Such an idea is entirely practicable. The little that has already been done is not without result, for we find some labour leaders, to whom not so long ago the idea of increased production was anathema, now advocating this necessity as essential to our welfare.

The political outlook is one of the most serious the employers have to face. The extensive programme of the Labour Party is well known and there is very little doubt that future parliaments will see an important addition to the strength of the workers. Their ambition for an accession of power in the legislature is reasonable, understandable, and perfectly legitimate. Their social and economic interests can be largely influenced by the Government of the day, and they would be foolish indeed if they neglected to exercise their utmost pressure to the end. But modesty and self-effacement are not their weaknesses, and that being so, it would surely be wise action on the employers' part, to take such steps as would ensure that the political power of Labour is not used to cripple our capacity for the fullest and cheapest production necessary to maintain our position in the world's markets.

The past few years have seen an unprecedented and undreamt of incursion by Government departments into the region of industrial control and negotiation. The conditions under which workmen may be employed are no longer a matter for determination by the men and masters, but are settled—sometimes arbitrarily—by the officials of Whitehall, and the classic example of the 12½ per cent. bonus to time-workers is an indication of the situations which may arise through the coadjutation of belligerent trades unionists and Government servants who feel themselves charged, at any price, to keep the industrial peace. It is no doubt true that the special circumstances may have called for special measures, but the machinery created is peculiarly adapted for manipulation by Labour, and Labour will never let it go if it can possibly be maintained.

Now there is no doubt that the employing class are well represented in the House of Commons, but they are represented by men who have large general interests and who, as a rule, have not an intimate personal knowledge of the subtleties and intricacies of workshop conditions. It is therefore extremely essential, in order to put a brake upon the tendency to improper interference by Government departments, that they should have associated with them a number of practical and expert men whose special responsibility would be to observe and influence departmental activities, and when occasion arose

direct effective attention to proposals likely to prejudice our national industrial interests. Such an action is not advocated in opposition to the reasonable aims of Labour, but because political balance is the surest safeguard against legislative tyranny, and when the whole trades union movement is throwing itself into the political struggle with all its strength, there is something in the circumstance which the employer had better study and mayhap reasonably copy.

These two examples may suffice to indicate what is meant by measures of safeguard; but necessary measures of progressive action might also indeed be characterised as measures of safety. Very few employers have ever really studied their workers as individuals. That is to say, they have made no attempt to probe into their minds and discover the promptings which define their attitude to industrial questions. They have never attempted to assess the influence of social, educational, and domestic conditions upon a man's workshop outlook. The question of maintaining industrial peace is not only a question of hours of labour and district rates of wages; its range is far wider and its roots deeper. Take an instance. The knowledge that only the accident of health stands between his family and physical want, creates in the mind of a thinking workman a bitter anxiety, and animosity against our organisation of society. He is always living more or less upon the border line of necessity, and when even for a time he is plunged into the abyss, he emerges a rebel and a potential cause of strife. Who can blame him? It should not be possible for any man who has lived a decent working life to suffer privation through circumstances beyond his own control, and it should not be possible for his women folk and children to suffer in any event. But until the principle of State Insurance has been greatly extended and developed, they will, and if this fact were closely analysed a surprising light would probably be thrown upon the origin of much social and industrial discontent.

The employer who argues that a consideration of this kind is no affair of his, is guilty of the most complete and amazing folly. Every influence, physical, educational, social, moral, which affects a worker's capacity or disposition to produce, should be as much an affair of the employer as the price of labour or the hours of work, and unless he helps the community to evolve a higher standard of social life, there is very little doubt that the workers will achieve their own salvation and the employers will have to pay. It is difficult to understand why, in the interests of industrial efficiency, we should give the most scrupulous attention to the lighting, ventilation, and sanitation of our workshops and ignore altogether the necessity for the same advantages in a workman's home. The housing conditions of most manufacturing areas can be clearly shown to be contributory causes to physical degeneracy, but equally important from our present point of view, can be proved to exercise a most sordid influence upon a man's mentality, disposition, and aspiration. In conjunction with this question is that of provision for the workers' leisure hours. Specialisation in factory life tends to a nerve-trying monotony, and the antidote of pleasant and healthful recreation would be a wise safeguard against the tension which now finds expression in workshop agitation and unrest.

Much might be said on the educational issue. Brain, for instance, is obviously a commercial and industrial asset, the development of which we have appalingly neglected, and the lad who is capable of assimilating knowledge should have the fullest opportunity to do so, regardless of his station in life or the financial standing of his parents. Some opposition to educational reform has recently arisen, on the ground that certain industries will be seriously prejudiced if a plentiful supply of cheap child labour is not available. If an industry can only exist by prostituting the natural gifts of the next generation of citizens, it should not exist at all; but, as a matter of fact, there is no doubt that other things being equal, the higher the standard of trained intelligence in an industry the more prosperous will that industry ultimately become. Moreover, power, allied to ignorance, is an extremely dangerous combination, and the industrial atmosphere would not be nearly so electrical and uncertain, the trades-union officials would lead more often instead of being driven, if the great mass of the workers did some independent thinking instead of accepting ready-made the views of those whose enthusiasm sometimes outweighs their judgment, and whose prejudices are stronger than their ability to reason.

Now these truths are so well known as to be almost commonplace, but there is no evidence that the organised employers have realised the necessity of taking any action with regard to them. The philosophy which relegates the employer, as such, to the sphere of the workshop and isolates him from the general interests of the community is absolutely wrong, and the sooner this fact is realised, the better it will be for the employing class. If our antagonisms are to develop with the strength of Labour it is quite evident that a time is coming when the economic fabric of the country will be shaken to its foundations, and if, as has been argued, the employer has it in his power to do something to create a truer perception of the issues and to remove the causes of much social bitterness, he is taking a grave risk if he neglects to exercise that power to the uttermost.

These considerations naturally belong to the larger outlook, and there are certain steps which might be immediately taken with great advantage to a better understanding. The workers distrust the employer because in part they do not understand his problems and responsibilities, nor how much for success or failure depends upon his leadership. They regard him simply as one who sits at the "receipt of custom" and discharge their obligations with the grace of an aggrieved taxpayer. As pointed out, their leaders speak spaciously of controlling industry, when, in fact, they are unable to control their own members; they preach economic hardship—with the employer in the dock—and ignore direct causes of hardship such as limitation of output and lost time. We can most quickly bring their eyes from the mirage on the horizon down to the inexorable facts with which we are faced daily, by establishing and making use of in the factory, in the industrial area, and nationally, effective means of discussing the various issues which from time to time arise.

The Industrial Councils recommended by the Whitley Commission—without the trimmings added by the Committee on Reconstruction—recommendations which were generally acclaimed and not adopted, provide a suitable machinery for attaining this end. When the rank and file realise that constitutional and statutory channels exist for the airing of their smaller grievances, a great deal of suspicion will be eliminated and misunderstandings obviated. The experienced works manager will agree that discontent generates in a factory at a most amazing speed, over the most trivial issues, and discontent which has no effective means of expression ultimately results in trouble. The importance too of the personal relation cannot be exaggerated and there is no doubt that the effect for good, of regular and recognised contact, will be enormous. A great deal of our unrest has arisen from the fact that the one side does not appreciate the other's difficulties or point of view; they have met only to fight, and there is much hope for a better understanding when they meet for a friendly interchange of views. There is every reason to believe that more intimate association with the workers will create amongst the employers a wider sympathy; and there is equal certainty that associations with the employers will develop amongst the workers a very necessary and valuable balance of judgment and keener sense of responsibility. They are essential to one another and ordinary common-sense prompts the belief that the closer they can approach each other the more prosperous their activities are likely to be.

As the considerations we have been discussing have been addressed more directly to the employers, a final suggestion may be permitted. They should endeavour, for their own ultimate advantage, to take a wide and liberal view of the future of Labour. They should regard the worker not as a means to an end—whose labour should be purchased as cheaply as possible—but as a social unit who is entitled to expect from industry, on account of services rendered, a recompense that will enable him to live a full, healthy, and happy life. They ought to recognise that the conditions under which a workman is reared, educated, and lives his domestic life, have a tremendous influence upon that man's workshop efficiency, and that in consequence they should as a class cultivate and exercise a liberal public spirit, if on no higher grounds than those of sound business investment; because in so doing they will undoubtedly take the best means of ensuring that the interests of the workers advance with, and not at the expense of, their own.

It may be, and doubtless will be argued in some quarters, that these conditions imply a revolutionary, unnecessary, and unprofitable departure from the attitude and ideas of the past. They may be regarded as sentimental considerations which are alien to a sound conception of business life. It may be suggested that the old methods of haggle and barter, dignified by the name of "wage negotiation," are sufficiently effective to safeguard the future, and that any attempt to more definitely assess the value of labour is a sign of weakness which will react upon the employer and tax his economic prosperity. But those who have some true understanding of the potential power of the worker, the development of the organised activities of Labour, the inevitable tendencies of the times, do not accept this view. They prefer to order change than be subject to the interminable series of crises which agitate the country, paralyse our industrial efficiency, and lead to a grand smash somewhere ahead; they realise clearly that those who mistake progress for sentiment are b'ind to many factors, psychological, social, economic, which have a vital effect upon our capacity for cheap production; they are convinced that if we fail to evolve some definite basis of compromise and to create effective machinery of negotiation in which the worker has a definite place and standing, the losses we have experienced in the past through the active opposition and passive resistance of Labour are as nothing to those which we are bound to sustain, at a time when all our forces and energies should be directed to the re-establishment of our industrial position. Events are marching throughout the world and the employers will profit most who march with them.

TEMPLETS, JIGS AND FIXTURES.

No. XIV.

By Joseph Horner.

Some fixtures and jigs for motor cylinder work are shown in this article, being selections from the practice of the Wolseley Motors, Limited, of Adderley Park, Birmingham. The first example relates to the boring and grinding of the twin cylinders, illustrated in Figs. 456 to 459, on page 423. The rear pair of cylinders only is shown, the front one is identical so far as the fixture work is concerned. The details of this, selected, include the boring of the cylinders, boring and reaming the valve-spindle guide holes, and grinding the seatings for the valve covers.

The first group of Figs., 460 to 462, shows a fixture in which two cylinder castings are mounted to be bored in a horizontal spindle machine. A cylinder is seen outlined in position in the view to the left, Fig. 460. The fixture is a very stiff casting bolted to the table of the machine through open-ended slot holes in lugs at the ends. It has six facings A, on the base, on which the valve facings A (compare with Fig. 457, of the cylinders) lie. The casting abuts by the flanges that terminate the bores against the vertical plate of the fixture, Fig. 460, to which they are clamped with clip plates and stud bolts. Two of these plates B, B, Fig. 461, come next each end, and one, C, which is longer than these, embraces the flanges of both cylinders about the centre of the fixture. Two other clips D, D, with coiled springs, clamp the lower portions of the flanges. The opposite ends of the cylinders are steadied with forked clamping plates E that enter the valve plug holes. One of these plates is shown in Fig. 463. Clamping plates in the end brackets F, Figs. 460 to 462, are brought into contact with the

JIGS AND FIXTURES FOR MOTOR CYLINDER WORK.

WOLSELEY MOTORS, LIMITED, ENGINEERS, ADDERLEY PARK, BIRMINGHAM.

Fig.456. SECTION AT A.A.

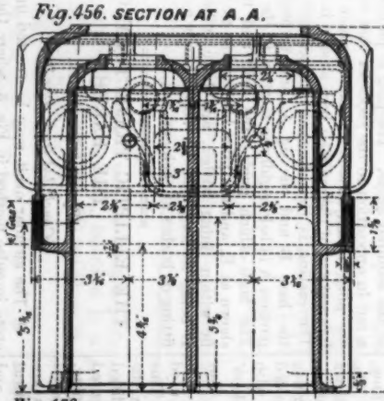


Fig.457. SECTION AT C.C.

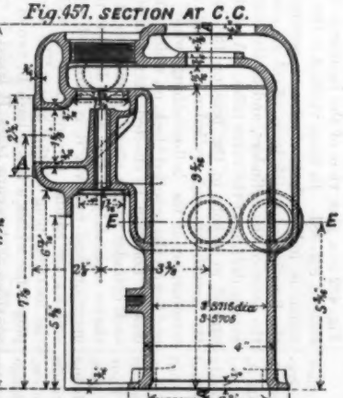


Fig.458.

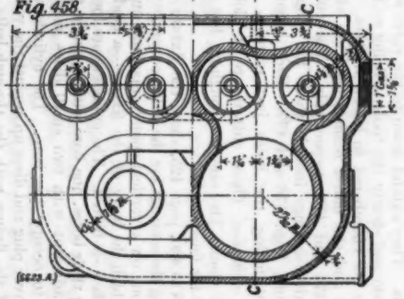


Fig.459. REAR CYLINDER. SECTION AT E.E.

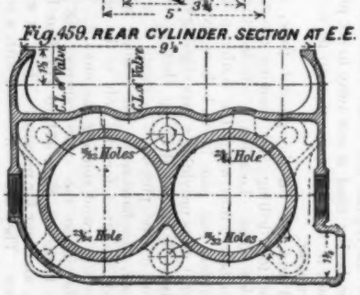


Fig.460.

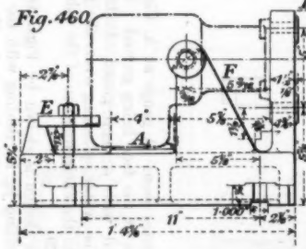


Fig.461.

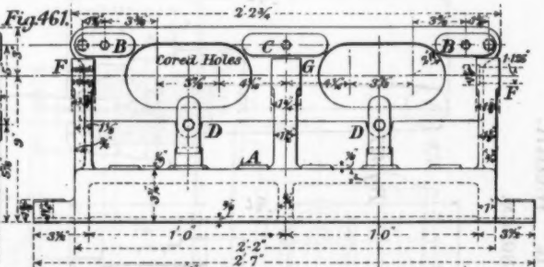


Fig.462.

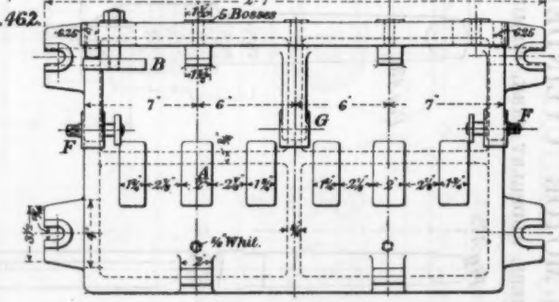


Fig.463.

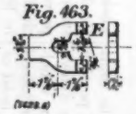


Fig.464.

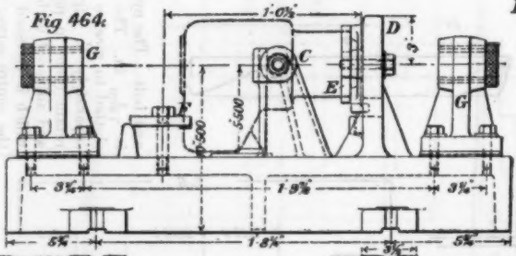


Fig.465.

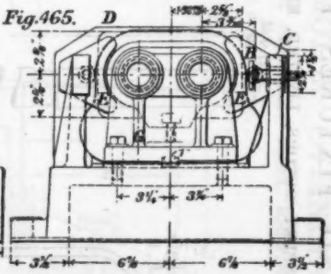


Fig.466.

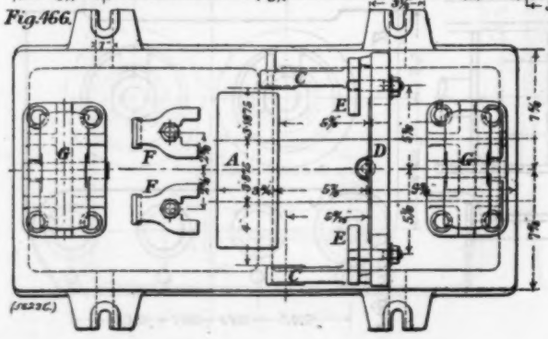


Fig.467.

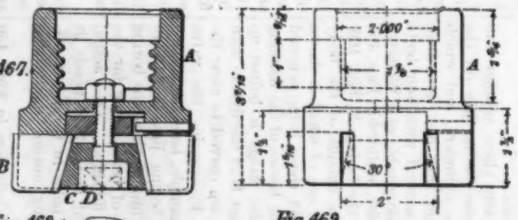
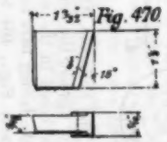


Fig.468.

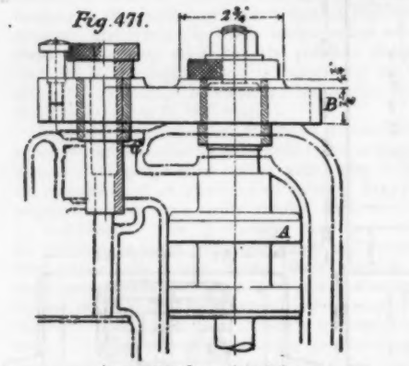
Fig.469.

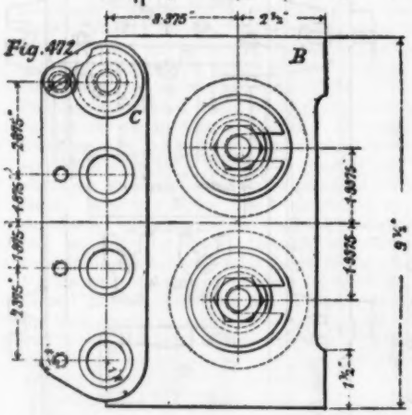
Fig.470.

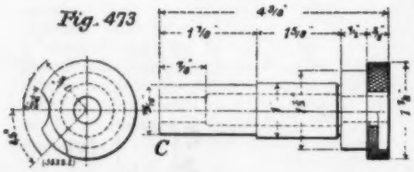


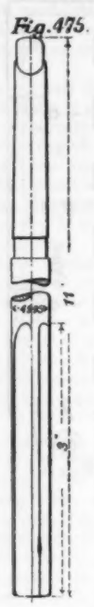
JIGS AND FIXTURES FOR MOTOR CYLINDER WORK.

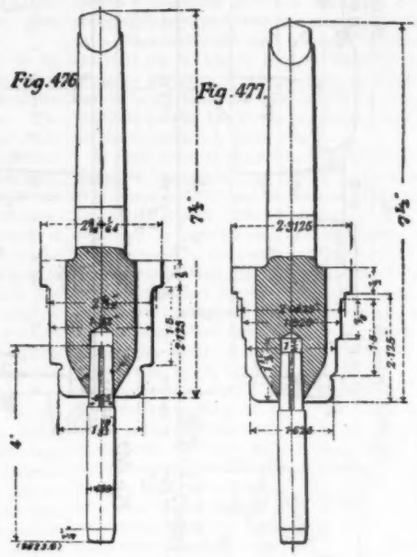
WOLSELEY MOTORS, LIMITED, ENGINEERS, ADDERLEY PARK, BIRMINGHAM.











sides of the cylinders, thrusting the castings into abutment against the central bracket G. Oblong holes are cored in the vertical plate, Fig. 461, to permit the boring bars to pass.

The next Figs., 464 to 466, show another and earlier fixture which includes boring jigs on the same base that carries the cylinders, and which differs in other details from that just described. Here a very rigid base is secured with four bolts in slot holes to the cross-sliding table of a Wolseley boring machine. The cylinder, outlined in Figs. 464 and 465, lies on its face on the facing A, Fig. 466. It is located laterally by the outside of the body with two clamping plugs B, one of which is shown at the right hand of Fig. 465, these being screwed into steel lining bushes in the bosses of the flanking brackets C, C. The cylinder flange is bolted up against the transverse bracket D of the fixture with clamping plates E, E, that are curved to clear the body. Forked clamps F, F, entering the valve plug holes, as in the last example, hold the casting down at that end. Two boring jigs G, G, are bolted down to the base. Through these the boring bars pass through two sets of bushes, one for the roughing, the other for finishing. The actual working bushes with flanged and milled heads fit within lining bushes. The holes in the jigs G, G, being bored in one casting ensure unalterable positions of the centres.

The cutter for boring the cylinders in Figs. 456 to 459 is shown by Figs. 467 to 470. Its head or body portion is screwed on the end of the bar of the boring machine. It carries six cutters which are adjusted for diameters in seatings having 15 deg. of angle and is secured by means of a central cone and bolt. The cylinder bores are 3½ in., the limit is $\frac{1}{1000}$ in. The body A has its lower portion slotted to receive the six cutters (one is shown separately in Fig. 470), the shoulders on which retain them in place. Endwise they are retained and adjusted with the central bolt D, the head of which is recessed for a tommy. The steel ring in the centre serves as a nut when fine adjustments are being made, being prevented from turning by the peg to the right which enters a shallow slot cut on one side, since when the head is screwed in its place the regular nut is not available. The body of the boring head is cut away in six places, Fig. 469, just in front of the cutters to permit the clips to get clear.

Figs. 471 and 472, on the present page, show a jig made for drilling and reaming the valve-spindle guide holes. Location is effected through the cylinder bores, into which the double plugs A, Fig. 471, enter, one pair in each bore (compare with Fig. 472), thus providing a firm aligning steady for the plate B of the drill jig that is bolted to the stems of the plugs. The stems fit within lining bushes, case-hardened. The washer with a milled head is slotted for the bolt to be moved laterally, and so avoid running the nut off. Four holes in the jig at the valve centres, Fig. 458, receive the bushes C, Figs. 471 to 473, four being for drilling, and four for reaming. These fit within lining bushes. They are each locked with a screw, the head of which bears in a recess cut in the flange of the bush. They extend down to the valve seats, and so guide and steady the tools. Being so long, their holes are chambered to lessen friction. The twist drill and the fluted reamer used are shown by Figs. 474 and 475, respectively. The cutters for the valve seatings include those for roughing and finishing, Figs. 476 and 477. Each is guided by a pilot fitting the holes just reamed, with $\frac{5}{10,000}$ in. of clearance. These cutters are of Vickers' high-speed steel. The one for roughing has four teeth, that for finishing has six.

Figs. 478 to 480, page 425, show the fixture used for grinding the seatings for the valve covers. This work is done on a vertical-spindle machine on the table of which the body of the fixture—a modified angle bracket—is bolted. The cylinders are located in pairs by their bores, one bore with a single plug, and that adjacent with two small discs disposed vertically to occupy the bore. The cylinders are pulled on over plug and discs up against the vertical member of the fixture with the through-bolts, and washer plates seen. A gauge at A, Fig. 480, tests the height of the face being ground. The table is surrounded with a deep guard of sheet iron to prevent the water splashing over, the guard being clamped to the encircling rim of the table as shown in Fig. 479.

Another design is shown by Figs. 481 and 482. It is a drilling jig for dealing with the valve holes of cylinders in which these holes lie at an angle with the axes of the cylinders. These having been bored and faced, afford the means of location adopted for the drilling and reaming of the valve holes. The general scheme is shown by Fig. 481, in which the position of the cylinder is outlined, Fig. 482 is a plan view of the jig drawn to half the scale of Fig. 481. In these views A is the jig-fixture which is independent of the supporting base B, the function of which is to afford an abutment to the faces of the cylinders, and at the correct angle for the drilling of the valve holes. A hardened plug carried in a hole in the boss on the base enters the mouth of each cylinder, locating it at the termination of the bell-mouthing, while the faced end lies on the bevelled block, on which it is clamped down. Location is effected at the blank end of each cylinder with a plug C ground to fit the bore, shown separately in Fig. 483. For the purpose of insertion and removal it is provided with a rod and looped handle, screwed into it, which clears the locating plug at the base. The stem of the plug C fits within a lining bush D, two of which are provided that occupy holes H bored in the fixture at the required angle. The plug is pulled up with a nut in opposition to the shoulder that terminates the plug, which shoulder makes contact with the internal end of the cylinder bore as seen in Fig. 481. The casting is thus located and secured between the base B and the jig A, and through it the portion A is held rigidly in relation to the cylinder. The bush which guides the drill and reamer is shown at E, and the pilot bush below at F. Both fit within lining bushes, and have milled heads. E being so long, has its bore chambered by the fitting of bushes at each end.

THE ELLIPTIC TRAJECTORY OVER THE EARTH.

By G. Greenhill.

(*Concluded from page 395.*)

9. The circular orbit may be treated in the discrete impulse method in Fig. 5, where the straight

JIGS AND FIXTURES FOR MOTOR CYLINDER WORK.

WOLSELEY MOTORS, LIMITED, ENGINEERS, ADDERLEY PARK, BIRMINGHAM.

(*For Description, see opposite Page.*)

Fig.478.

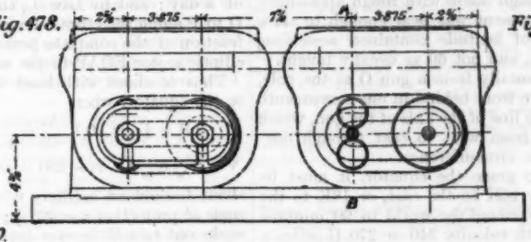


Fig.479.

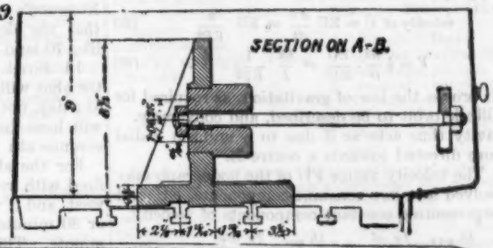
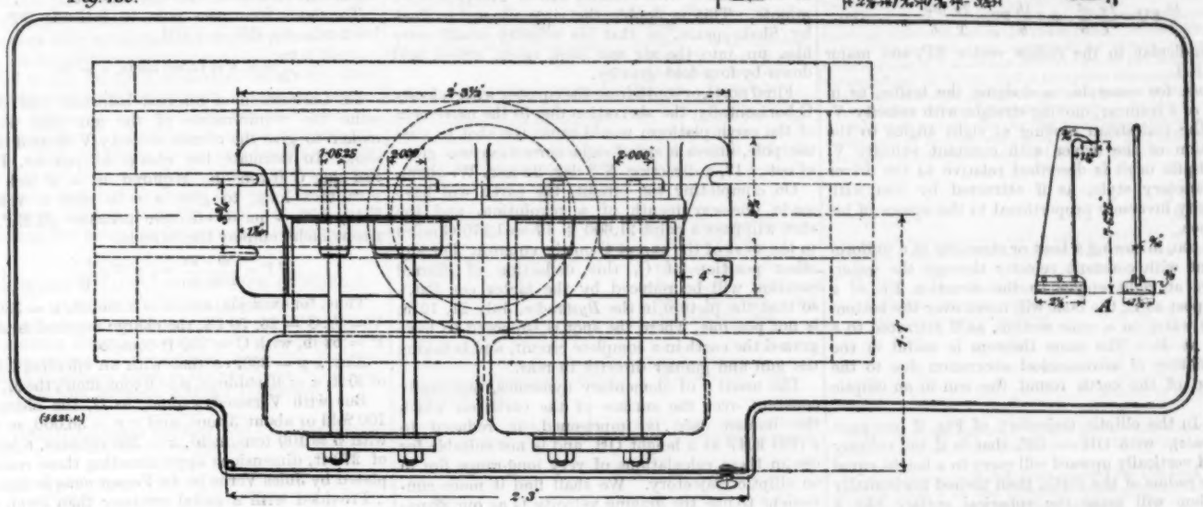


Fig.480.



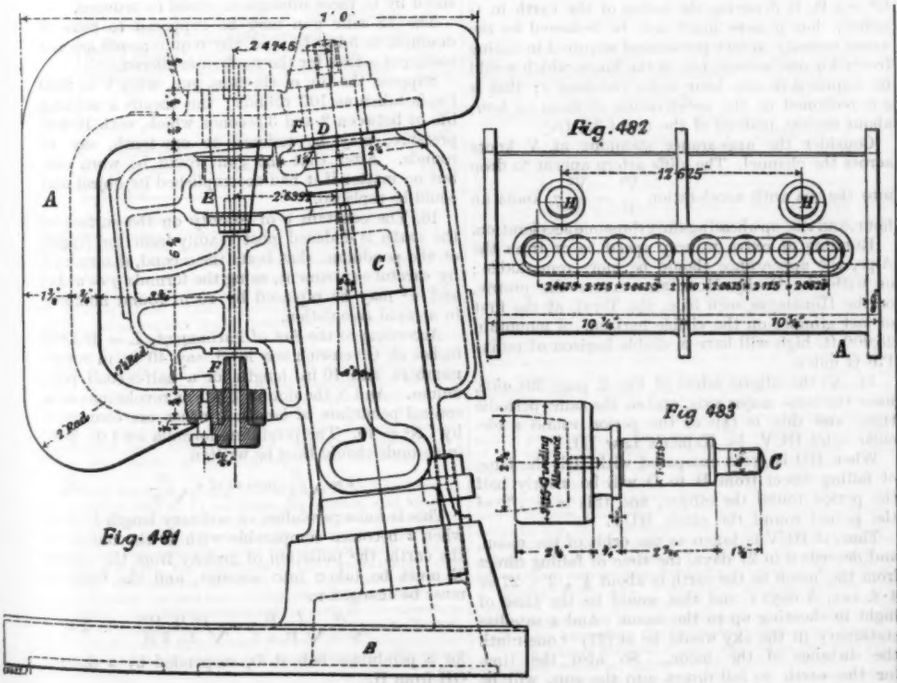


Fig.481

Fig.482

Fig 483

line path AQR is changed into the broken path AQQ_2 of equal chords AQ, QQ_2, inscribed in a circle of radius R; where $AQ = QR = QQ_2 = Vt$, and $RQ_2 = Ut$ is parallel to EQ.

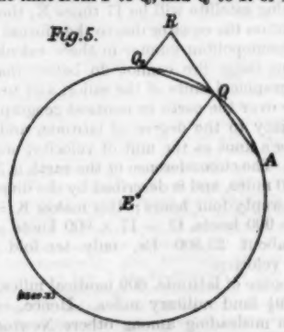
The triangles RQQ_2, Q_2QE are similar,

$$R\,Q_2 = \frac{Q\,Q_2^2}{E\,Q}.\ U\,t = \frac{V^2\,t^2}{R}.\ \frac{U}{t} = \frac{V^2}{R}. \qquad (14)$$

and U/t measures the average acceleration to generate velocity U in time t.

10. We can proceed next to show how these equal intermittent impulses at equal angular interval tend, as they are made more and more frequent, to be equivalent to a field of gravitation, of intensity inversely as the square of the distance from E, in accordance with Newton's enunciation. In the first place, Law II. of Kepler can be deduced in Newton's manner, by comparing the position of the body after passing through Q, according as the impulse is applied at Q, or not. If the blow is not applied at Q, the body, instead of reaching P_2 will, in the same time, have come to R in PQ produced (Fig. 4, page 395 *ante*), such that RP_2 is parallel to the impulse in QE, and the triangles P_2EQ, REQ are equal. But the ratio of these triangles is the ratio of the time from P to Q, and Q to R or P_2; and

Fig.5.



the equal triangles P_2EQ, REQ bear the ratio to the triangle PEQ of the time of describing them; thus the sector area swept out round E will be proportional to the time, whether the central impulse does or does not act; and this is sufficient to demonstrate Kepler's Law II.

Denoting the constant sector velocity as usual by h, then in Fig. 2, page 394 *ante*.

$$h = EP^2 \times \text{angular velocity of EP} = EY \times \text{linear velocity of } P \qquad (15$$

and since $EY.FZ = b^2$ in an ellipse, the linear velocity of P,

$$v = \frac{h}{EY} = \frac{h}{b^2}\,FZ = \frac{h}{b^2}\,FU.$$

As EP turns through a small angle $d\vartheta$ in time dt

and P moves to an adjacent point Q on the ellipse, and U to V, the velocity communicated is proportional and perpendicular to UV, or directed to E; and denoting the intensity of the force by F, in dynes/gramme, of dimensions (LT^{-2}),

$$\frac{F\,dt}{v}=\frac{UV}{FU}=\frac{EU}{FU}\,d\theta,\ F=\frac{v\text{ velocity of U}}{FU}=\frac{\frac{1}{2}h}{l^2}\text{ velocity of U} \quad (17)$$

$$\text{velocity of U}=EU\frac{d\theta}{dt}=EU\frac{h}{EP^2} \quad . \quad . \quad (18)$$

$$F=\tfrac{1}{2}\frac{h^2}{l^2}\cdot\frac{EU}{EP^2}=\frac{h^2}{l}\cdot\frac{1}{EP^2} \quad . \quad . \quad . \quad (19)$$

which proves the law of gravitation, as required for the elliptic orbit to be described, and conversely.

Gravity thus acts as if due to a uniform radial pressure directed towards a centre E.

11. The velocity vector FU of the hodograph may be resolved into two constant components, EU and FE, representing constant components of velocity,

$$\frac{\frac{1}{2}h}{l}EU=\frac{2\pi}{T}\frac{a^2}{b},\text{ and }\frac{\frac{1}{2}h}{b}FE=\frac{2\pi}{T}\frac{a^2e}{b}, \quad . \quad (19)$$

perpendicular to the radius vector EP, and major axis EH.

Thus, for example, in dodging the traffic, as in front of a tramcar, moving straight with velocity V, and the pedestrian moving at right angles to the direction of the driver with constant velocity V, an elliptic orbit is described relative to the driver in planetary style, as if attracted by him with intensity inversely proportional to the square of his distance.

So, too, in rowing a boat or steaming in a uniform current with constant velocity through the water, always at right angles to the direction PE of a fixed post at E, the boat will move over the bottom of the water on a conic section, as if attracted to a focus at E. The same theorem is useful in the explanation of astronomical aberration due to the motion of the earth round the sun in an elliptic orbit.

12. In the elliptic trajectory of Fig. 2 (see page 394 *ante*), with OH = OE, that is if the velocity turned vertically upward will carry to a height equal to the radius of the earth, then turned horizontally the shot will graze the spherical surface like a satellite, in a circular trajectory with F coincident with E.

A higher velocity of horizontal projection would give an elliptic trajectory clearing the earth and returning to O; and to reach a range OR the high-angle trajectory must be used, as direct fire would drive through the earth, unless the gun was turned right round, and the shot sent round the world the other way about, as in Fig. 2.

On the usual assumption that gravity at the equator may be taken as 289 times the centrifugal force of the rotation of the earth, the velocity G of the grazing satellite will be 17 times K, the velocity of a point on the equator due to the diurnal rotation.

The cosmopolitan gunner in these calculations of very long-range fire cannot do better than adopt the geographical units of the sailor, and to measure distance over the earth in nautical geographical (G) miles, sixty to the degree of latitude, and to take the sailor's knot as the unit of velocity, one G mile an hour. The circumference of the earth is $360\times60=21{,}600$ miles, and is described by the diurnal rotation in twenty-four hours; this makes $K=21{,}600\div24=900$ knots, $G=17\times900$ knots $=15{,}300$ knots, about 25,500 f/s, only ten-fold modern artillery velocity.

The degree of latitude, 609 nautical miles, is more nearly 69½ land military miles. Hence, erroneous estimates misleading among others Newton in his first attempt at a verification of his theory of gravitation, applying it as a test on the moon.

The record is preserved for us by Voltaire in his "Elémens de la Philosophie de Newton," 1738, lost otherwise, of the story of Newton and the apple; and as the reference is not given by Brewster and others and is difficult to retrieve, it may be quoted here. "Un jour de l'année 1666, Newton, retiré à la campagne, et voyant tomber des fruits d'un arbre, à ce que m'a conté sa nièce (Madame Conduit) se laissa aller à une méditation profonde sur la cause qui entraine ainsi tous les corps dans une ligne qui, si elle était prolongée, passerait à peu près par le centre de la terre." So it was curious to hear Poincaré class the story among the fables of antiquity in his address to the Mathematical Congress in Rome, 1908.

Voltaire goes on to express surprise that Newton should have been ignorant of Norwood's measurement of an arc of the meridian from London to York, made in 1636, 30 years earlier than Newton's conjecture. Although made with rough appliances, Norwood's measurement was near enough to show that the degree of latitude contained something like 70 land miles, and not 60 as usually taught.

13. Fired horizontally from a gun O at the pole, the shot will arrive from behind in one-seventeenth of a day, not in the line of the axis of the gun, which will have turned from west to east through one-seventeenth of the circumference.

For the shot to graze the equator, it must be fired with velocity 16K to the east, or 18K to the west, and it will go round the world in 90 minutes or 80 minutes, with velocity 240 or 270 G miles a minute. This is double the time allowed to Puck by Shakespeare, so that his velocity would carry him up into the air and back again, unless held down by four-fold gravity.

Fired north or south from the equator with velocity G horizontally, the aberration due to the movement of the earth platform would cause the shot to miss the pole, unless a speed sight correction was given of $\cot^{-1}17$, a direction N 3 deg. 22 min. W. about.

On completing the circuit, the earth will have made one-seventeenth of a revolution, and the shot will pass a point $21{,}600\div17=1{,}270$ G miles to the west of the gun at O on the equator. For any other position of O, this deflection of diurnal rotation will be reduced by the factor cos (lat.), so that the picture in the *Bystander*, July 21, 1915, is not possible, where the shot is supposed to have grazed the earth in a complete circuit, and is taking the gun and gunner directly in rear.

The usual g of elementary dynamics, practically constant over the surface of the earth on which the human race is imprisoned, is reduced to $g\,(EO/EH)^2$ at a height OH, and is not suitable for use in these calculations of very long-range fire in an elliptic trajectory. We shall find it more convenient to use the grazing velocity G as our dynamical constant, connected with g by the relation $G^2=g\,R$, R denoting the radius of the earth in G miles; but g here must not be reckoned by the usual velocity in feet per second acquired in falling freely for one second, but in the knots which would be acquired in one hour under constant g; that is g is reckoned in the acceleration of *knots an hour*, about 68,000, instead of the usual 32, f/s².

Consider the appearance steaming at V knots across the channel. The cliffs astern appear to drop into the sea with acceleration $\frac{V^2}{R}=\frac{V^2}{G^2}g$, knots an hour, and rise up ahead against the same acceleration.

Running at extra railway speed to or from the Alps, the appearance should be more remarkable; or with the Rocky Mountains across the prairie, or the Himalayas seen from the Terai, at the first or last glimpse on the visible horizon. A mountain 25,000 ft. high will have a visible horizon of radius 176 G miles.

14. All the elliptic orbits of Fig. 2, page 394 *ante*, have the same major axis, and so the same periodic time, and this is $(\frac{1}{2})^{\frac{3}{2}}$ of the period round a circular orbit HUV. by Kepler's Law III.

When HO is great compared with OE, the time of falling direct from H to O will be nearly half the period round the ellipse, and this is $\frac{1}{4}\sqrt{2}$ of the period round the circle HUV.

Thus, if HUV is taken as the orbit of the moon, and described in 27 days, the time of falling direct from the moon to the earth is about $\frac{1}{4}\sqrt{2}\times27=4{\cdot}8$, say, 5 days; and this would be the time of flight in shooting up to the moon. And a satellite stationary in the sky would be at $(27)^{\frac{2}{3}}$ one-ninth the distance of the moon. So also the time for the earth to fall direct into the sun, will be $\frac{1}{4}\sqrt{2}\times365=65$ days, a little over two months.

Then, if V is the velocity in knots required to send a shot from O vertically up to H:

$$\tfrac{1}{2}V^2=gK^2\left(\frac{I}{Eo}-\frac{I}{EH}\right)=gK\frac{OH}{EH}\cdot\frac{V^2}{G^2}=2\frac{OH}{EH} \quad . \quad (29)$$

The period of a grazing satellite going round 17 times a day may be taken as 84 minutes, the harmonic mean of 80 minutes and 90 minutes, times of the westward and eastward circuits round the equator. Then by Kepler's Law III., the period of a complete circuit of the elliptic orbit in Fig. 2, will be

$$\frac{1}{17}\left(\frac{EH}{2EO}\right)^{\frac{3}{2}}=\frac{1}{17}\left(\frac{G^2}{2\,G^2-V^2}\right)^{\frac{3}{2}}$$

of a day; and by Law I., the time of flight from O to P along the elliptic trajectory OAP is the same fraction of the complete period as the ratio of the elliptic sector EOAP to the area of the ellipse.

Thus to shoot with least velocity from the pole to the equator, when

$$OH=\tfrac{1}{2}\sqrt{2}\,.\,OE,\ \frac{V^2}{G^2}=\frac{\sqrt{2}}{1+\frac{1}{2}\sqrt{2}}=2\sqrt{2}-2$$

$V=G\sqrt{(2\sqrt{2}-2)}=0.91$ G, say 13,800 knots, 23,000 f/s

about tenfold an artillery velocity at present; the angle of projection $\alpha=22°\,\frac{1}{2}$; and the time of flight works out to a little over half an hour.

To shoot from the pole to latitude 30° with least velocity, $OH=\frac{1}{2}OH$,

$$\frac{V^2}{G^2}=\frac{3}{4},\ V\text{ is }12{,}500\text{ knots},\ \alpha=15° \quad . \quad (16)$$

15. Calculation of internal ballistics will determine the requirements of the gun and powder maker to give the muzzle velocity V desired in the shot. To estimate the charge of powder, P lb., real sing C ft-tons/lb., required in a d inch gun, x calibres long, to give a w lb shot a velocity V f/s, with a mean effective pressure (M.E.P.) of p tons/inch², employ the formula,

$$C\,P=\frac{w}{2240}\frac{V^2}{2g}=\tfrac{1}{4}\pi\,d^2\,p\,\frac{x\,d}{12} \quad . \quad (17)$$

Thus, for example, with $d=9$ inches, $w=380$ lb., $V=\frac{1}{10}G=25$, 50 f/s, the charge required is about P = 68 lb, with C = 250 ft-tons/lb.

Also $x\,p=360$, so that with an effective length of 30 ft, $x=40$ calibres, $p=9$ tons/inch², the M.E.P.

But with V raised tenfold, to G, the charge is 100 fold or about 3 tons, and $x\,p=36{,}000$, so that with $p=100$ tons/inch², $x=360$ calibres, a length of 270 ft, dimensions approximating those contemplated by Jules Verne in *Le Voyage dans la Lune*.

Provided with a metal stronger than steel, and with an increased "furie of the poulder" as measured by C, these dimensions could be reduced.

The 75 mile gun may be supposed to have V doubled, to 5,100 f/s, and the requirements are not too great a task for the modern artillerist.

Suppose the life of the 9-in. gun, with V = 2550 f/s, is taken as 100 rounds; this means a working life of between 2 and 3 seconds which, with 10-fold pressure, may be reduced to one-tenth, say 10 rounds. After that the gun would be worn out, but no matter if it had accomplished its object and could be replaced.

16. The constant g of gravity on the surface of the earth is deduced most readily from the length of the pendulum that beats the second, determined by careful experiment, using the formula $g=\pi^2L$; and π^2 may be replaced by 10 in round numbers in a rapid calculation.

According to the Act of Parliament, L = 39.1393 inches at Greenwich sea level, say 40 in. in round numbers and 10 in. length for a half-second pendulum. And N the double beats or revolutions as a conical pendulum of length l inches are connected by $l\,N^2=10$. The pendulum formula for t the beat in seconds should then be written

$$t=\sqrt{\frac{l}{L}},\text{ instead of }\pi\sqrt{\frac{l}{g}} \quad . \quad . \quad (20)$$

This is for a pendulum of ordinary length l; but when l becomes comparable with R the radius of the earth, the radiation of gravity from the centre E must be taken into account, and the formula must be changed to

$$t=\sqrt{\frac{l}{L}}\sqrt{\frac{R}{R+L}}=\sqrt{\frac{E\,O\,.\,OH}{L\,.\,EH}} \quad . \quad (21)$$

for a pendulum bob at O, suspended by a thread OH from H.

Thus for infinite length l, the beat is not infinite, but $\pi\sqrt{\frac{E\,O}{g}}$, that is 34 times a day, the period of double beat being the same as of the grazing satellite. And with $l=OH=OE$, the pendulum would beat $34\sqrt{2}=48$ times a day, a period of one hour. Infinite l may be realised with a railway line, not curved to the surface bulge of the earth but laid

perfectly straight, and then a truck on it could oscillate 17 times a day about the position of equilibrium.

The diametral tunnel to the antipodes, imagined by Socrates in Plato's *Phædo* LX., filled up with water, would have an oscillation of 17 tides a day, provided it did not boil off under the central heat. The same would hold for a tunnel driven through in any other direction as a chord of the earth, as in a channel tunnel, driven straight so as to be seen through, and not level and curved. These speculations are not of mere abstract interest, but are required to-day in calculations of the behaviour of the Gyro-Compass.

Maxwell, in his essay on Saturn (*Scientific Papers*, vol. I.) had recourse to a theory of a dusky ring, assimilated to the state of our air during a siege of Sebastopol, where the shot never stop, but go round Saturn in a circle of mean diameter 170,000 miles, in a ring 100 miles thick one way and 30,000 miles wide the other. To-day the siege of Sebastopol strikes as a puny affair compared with recent daily artillery long-range bombardments. When his mechanical model was exhibited of Saturn and his rings, Maxwell remarked how the anatomist seemed most interested, recognising as he thought some of his own disembowelled representations; but it left the mere mathematician unmoved, as it is likely these speculations on long range fire will leave the old-fashioned gunner. But then recent history has proved he cannot be said to have known what it spelt, the word Artillery, such as we shall see when the German fleet comes out.

ELECTRIC TRACTION ON THE CENTRAL ARGENTINE RAILWAY.

We are indebted to Messrs. Merz and McLellan for the following description of the electrification of the suburban sections of the Central Argentine Railway, for which they have acted as the engineers in conjunction with Messrs. Livesey, Son and Henderson.

The Central Argentine Railway with a present mileage of 3,300 serves the northern portion of the Argentine between Tucuman, Cordoba and Rio Quarto on the west and Santa Fé, Rosario and Buenos Aires on the River Plate. The number of passengers carried on the system during the twelve months ending June, 1914, was 23,000,000, of whom 16,000,000 were carried on the three sections which serve the north-western suburbs of Buenos Aires. The explanation of the large ratio which the suburban traffic bears to the total traffic is found in the fact that Buenos Aires, with a population of over 1,500,000, contains more than one-fifth of the whole population of Argentina. The city handles more than half (in value) of the total imports and exports of the country, and new docks are under construction which will increase the capacity of the port by more than 50 per cent.; all the great railways, British engineered and British owned, converge towards it; it is the centre of government, and its climate is good.

During the last twenty years its growth has been at the average rate of 7½ per cent. per annum, and there is every reason to believe that this rate will be maintained during the next twenty years. Realising the importance of dealing economically with the development of their suburban traffic, the directors of the Central Argentine Railway decided to electrify the suburban sections, and the work was put into the hands of Messrs. Merz and McLellan, who were instructed to act in co-operation with the consulting engineers of the company, Messrs. Livesey, Son and Henderson, the two firms being jointly responsible for the design and supervision of the whole equipment.

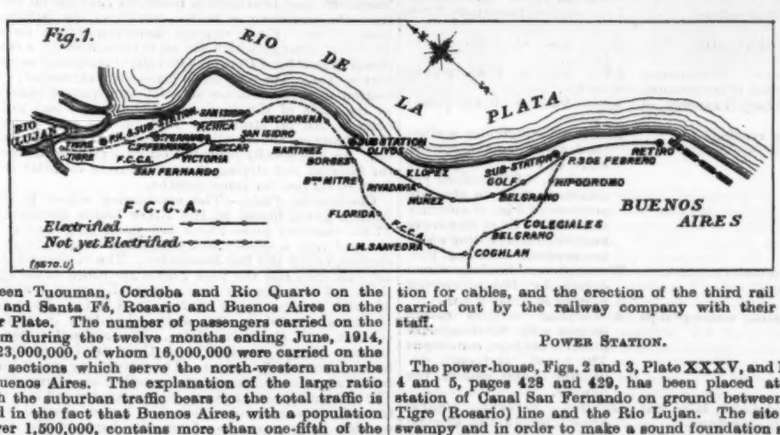
On August 24, 1916, the President of the Republic, Dr. Victorino de la Plaza inaugurated electric traction on the line from Retiro Terminus in Buenos Aires to Tigre on Las Conchas River, *via* Victoria. The Central Argentine Railway thus had the distinction of being the first of the great railway lines in the Argentine to adopt the modern method of dealing with suburban traffic. The service on the branch has operated with marked success not only from the engineering but also from the traffic point of view, the passenger journeys in the first six months of the year 1917 being some 11 per cent. in excess of the figures for the corresponding period of 1916.

The complete electrification works for the suburban system include a power station of 15,000 kw. capacity, 57 miles of high-tension transmission cables, four traction substations with 14,000 kw. of converting plant and the electrical equipment of 100 miles of single track. Power is produced in the generating station as three-phase current at 20,000 volts with a periodicity of 25 cycles, transmitted to the substations, converted to direct current at 800 volts and supplied to the trains through a third rail. The suburban route of the Central Argentine Railway already electrified is shown in Fig. 1 with the location of the power station and existing substations. The whole of the apparatus used in connection with the electrification was manufactured in Great Britain and the principal contracts covered the erection of their plant by the various contractors; they are set out in Table I.

TABLE I.

Power station buildings and complete boiler-house equipment.	Babcock and Wilcox, Ltd.
Turbo-alternators, transformers and motors.	C. A. Parsons & Co., Ltd.
Condensing plant and pumps...	British Westinghouse Electric and Manufacturing Co., Ltd.
Switchgear in power station auxiliary motors, &c.	British Thomson-Houston Co., Ltd.
High-tension transmission and low-tension track cables.	W. T. Henley's Telegraph Works, Ltd.
Structural steel work for power station entrance way, test-room, offices and sub-stations; also the cranes for the substations.	David Rowell and Co., Ltd.
Electrical equipment of sub-stations, &c.	British Thomson-Houston Company, Ltd.
Rolling-stock—bodies underframes and bogies.	Metropolitan Carriage Wagon and Finance Co., Ltd. Birmingham Carriage and Wagon Co., Ltd.
Rolling-stock — electrical equipment.	British Thomson-Houston Co., Ltd.
Supervision of erection of electrical equipment of permanent way.	British Thomson-Houston Co., Ltd.

The provision of the foundations for the power station and substations, the walling of the substations, excavation for cables, and the erection of the third rail were carried out by the railway company with their own staff.



POWER STATION.

The power-house, Figs. 2 and 3, Plate XXXV, and Figs. 4 and 5, pages 428 and 429, has been placed at the station of Canal San Fernando on ground between the Tigre (Rosario) line and the Rio Lujan. The site was swampy and in order to make a sound foundation some 3,000 ferro-concrete piles were driven down 33 ft. till they reached the hard clay (tosna) which is found at varying depths all around Buenos Aires. On top of the piles a concrete raft, 2 ft. 6 in. thick, reinforced with old rails, was formed, to which pipes were laid for the cables serving the apparatus in the station. The level of the engine-room floor is 4·50 m. above datum. This was fixed with reference to the highest recorded flood level, 4·07 m.; since the station was built flood water has reached 4·38 m. above datum. The site plan of the power station is shown in Fig. 1 and the general arrangement in Fig. 3. The engine-room and boiler-house are arranged parallel to each other with coal and ash-handling sidings behind the latter. In front of the engine-room are a rotary converter substation, laboratory and offices. A fitting shop and workmen's accommodation are provided at the permanent end of the engine-room. There is space on the site to double the capacity of the station by extending the buildings towards the river.

The buildings are steel-framed structures panelled with armoured concrete, finished with a white cement. The roofs of the substation and offices are concrete; that of the boiler-house is corrugated iron. The engine-room roof consists of a wood ceiling covered with waterproof felt and with corrugated iron on top; this construction was required to avoid the condensation of moisture from hot humid air striking a cold corrugated iron roof.

Boiler-Houses.—Table II gives particulars of the principal plant in the boiler-house.

TABLE II.—*Details of Boiler-House Plant.*

Number and type of boilers	Six Babcock and Wilcox marine type water-tube boilers.
Normal evaporation of each boiler.	20,000 lb. of water per hour.
Working steam pressure and temperature.	210 lb. per square inch; 600 deg. F.
Heating surface of each boiler.	4,170 sq. ft.
Grate area of each boiler...	98 sq. ft.
Type of stokers	Underfeed.
Type and size of economisers.	Green's; 200 pipes in each.
Number of fans	8 "Sirocco" fans.
Number and type of feed pumps.	2 impulse turbine-driven centrifugal pumps. 2 vertical reciprocating, Nichol's type. Capacity of each feed pump: 75,000 lb. per hour.

The boilers are arranged four a side, grouped in pairs, each boiler having its own superheater and economiser One steel chimney with an induced-draught fan serves each pair of boilers and forced draught is supplied to the furnaces by four fans in the basement. The furnaces are lined with Glenboig bricks and are suitable for burning either Welsh or Durham coal. The stokers are of the underfeed type operated by steam rams. In anticipation of a shortage of coal two of the boilers were arranged for oil firing, and a complete equipment of the Wallsend-Howden system has been put into operation, with storage tanks, filters and pumps. As the shortage of both coal and oil, due to war conditions, became more acute, other boilers were adapted for wood firing and the fuel consumption figures for a recent week are:—

	Tons.
Coal	72·5
Oil	15·5
Wood	690·0

The wood burnt is red and white quebracho and algarrobo, and the relative values of the different fuels are, roughly, as follows:—

1 lb. of coal (calorific value 15,000 British thermal units) is equivalent to ...	0·8 lb. of oil.
" "	2·5 lb. of red quebracho.
" "	3·3 lb. of white quebracho.
" "	3·3 lb. of algarrobo.

The combined efficiency of the boilers and economisers works out at about 85 per cent. when Welsh coal is being burnt.

A high-pressure water main served by the feed pumps gives a supply to fire hydrants throughout the boiler-house and also for boiler-tube cleaning. The feed pumps draw their supply from hot-well tanks in the pump-house and the make-up water comes from a storage reservoir, constructed alongside the power station, to two storage tanks erected above the hot wells. Water is pumped from the River Lujan through a 6-in. pipe to the reservoir, and is there treated with alumino-ferric to precipitate the sediment which the river water contains.

The steam piping consists of a range of solid-drawn pipes, the flanges, of forged steel, being riveted in the case of pipes of 7 in. diameter and over, and screwed in the case of smaller pipes. The blow-off piping is solid drawn steel and connects to a blow-off sump formed of a boiler drum. The exhaust and escape steam piping is lap-welded.

Coal and Ash-Handling Plant.—The storage and handling of coal is provided for by means of an elevated railway track running alongside the boiler-house at firing-floor level, a gantry parallel to the buildings and carrying a level-luffing jib crane, with a grab of 2 tons capacity, and two sidings at ground level. The coal tracks are brought on the site from the main line at Canal San Fernando Station, and the coal can be grabbed from them and either tilled direct into two 15-ton receiving hoppers, or into bottom discharge wagons which can be hauled along the elevated siding by a winch till they come over the receiving hoppers; thence the coal passes through crushers to gravity bucket conveyers. These elevate it to a tray conveyer, which takes it to coal bunkers above and between the two ranges of boilers. The coal bunkers have a capacity of 1,000 tons; they are built of mild steel plates lined with armoured cement and the bottoms are "V" shape in section. Alternatively, the arriving trucks can be pushed direct up the 1 in 25 incline to the elevated siding and the fuel—coal or wood—can be discharged direct on to the firing floor by hand. The stock coal is grabbed from the trucks and stored below and around the gantry in a coal deposit floored with sleepers and constructed within range of the jib crane which can plumb to a radius of 50 ft. The capacity of the store is 10,000 tons. The ash-handling arrangements comprise a suction ash plant with two 38-h.p. exhausters which take the ashes from the furnace ash pits through electrically-operated crushers and specially heavy cast-iron pipes to a mild steel ash bunker of 80 tons capacity lined internally with armoured concrete. The bunker is erected at the end of the boiler-house at such a height that railway trucks can pass underneath to receive and remove the ashes. Alternatively, the ashes can be taken from the ash pits by ¼-ton wagons along rail tracks laid along each side of the boiler-house basement, and deposited outside on the site.

Engine-Room.—The generating plant is so arranged

ELECTRIC TRACTION ON THE CENTRAL ARGENTINE RAILWAY.

MESSRS. MERZ AND McLELLAN AND MESSRS. LIVESEY, SON, AND HENDERSON, ENGINEERS, LONDON.

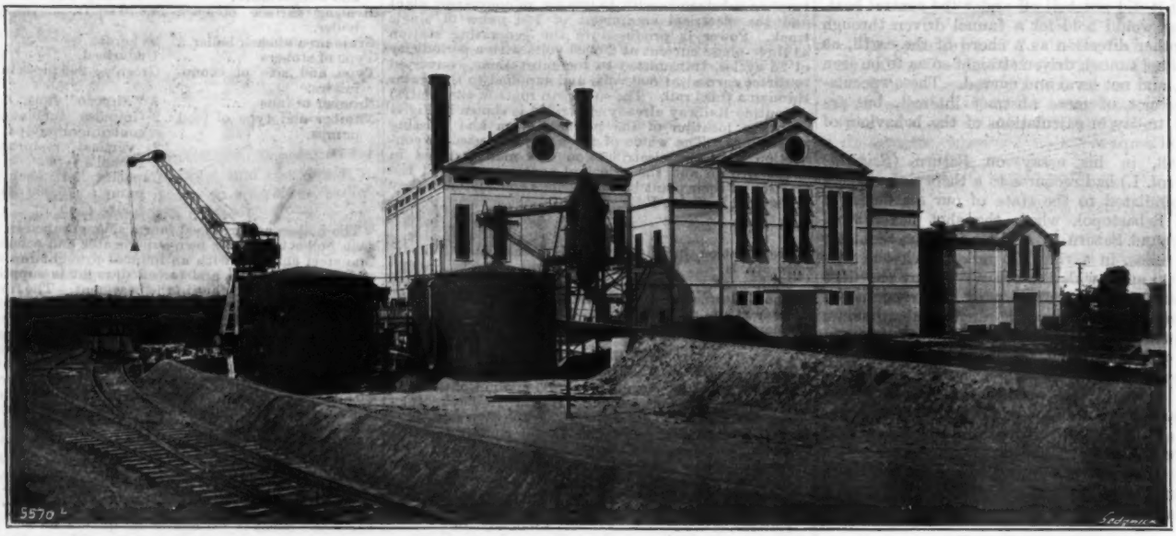


Fig. 4. Power House at Canal San Fernando.

that provided one boiler is steaming any one of the turbo-alternators can be started up and can give a supply to the main bus-bars and to all the station auxiliaries. In addition, the breakdown of anything comprised in one generating unit will not prevent the operation of the remaining sets. There are four turbines in the engine-room (see Fig. 5); each has its own steam-driven oil pump for use when starting up, its own condenser with air and water-extraction pumps, and an independent circulating water pump. On the electrical side it has a self-excited exciter direct-coupled to the alternator shaft; leads from the alternator run direct to the "unit" transformer which steps down the generated voltage from 2,500 to 440 and gives a supply to the unit distribution board. From this board are fed the motors which operate the auxiliaries definitely belonging to the generating set to which it is attached, viz., those driving the air pump, exhaust valve, step-up transformer oil pump and circulating water pump. The other station auxiliaries which are common to the whole station, *e.g.*, economiser and fan motors, are fed from a station distribution board divided into four sections, each of which can be isolated at will and fed from one of the unit boards, the feeders to the auxiliaries being so distributed among the sections that failure of one section will not put out of operation all the individual pieces of any auxiliary gear. The main leads from the alternator (1 sq. in. single-core cable) run to a step-up transformer, housed in the same compartment as the unit transformer, which steps up the generated voltage from 2,500 to 20,000, at which pressure the power is supplied to the station bus-bars. The station equipment as a whole is divided into two independent parts either capable of running without the other. The main bus-bars are divided in the middle by a bus-bar sectioning switch, two generators feed each half, and from each half a supply is given to a "station" transformer. Either of these station transformers can feed the station distribution board, the four sections of which are normally run coupled up. Connected to the extreme sections of the station distribution board are two motor generators giving a supply for lighting the station and for charging the two batteries which form a duplicate source of power for the tripping coils on the switches and the indicating lamps on the switchboard. The main outgoing feeders are distributed between the bus-bar sections so that failure of one section will not shut down any substation.

Details of the engine-room plant are given in Table III.

The turbines have their high and low-pressure portions in separate cylinders, the high-pressure cylinder being of cast steel. This was steamed with superheated steam for 24 hours, both before and after blading. The rotor shafts and drums are forged solid of steel with a tensile strength of 35 tons to 40 tons and an elongation of 20 per cent. The blades are brass. Each turbine is connected by an expansion pipe to the condenser situated underneath it. Between the turbine and the hand or electrically-operated main exhaust valve is an atmospheric release valve. The governor is mechanical and automatic in action and so constructed that the speed between no load and maximum load can be varied 5 per cent. up or down while the turbine is running. The speed can also be controlled by hand or from the switchboard by electrical means. Oil is supplied continuously under pressure to the bearings whence it passes through strainers to the oil reservoir to be picked up by an oil pump and forced through the tubes of an oil cooler.

Table III.—*Details of Engine-Room Plant.*

Number and type of turbines.	4 Parsons' horizontal reaction turbines with high and low pressure cylinders.
Working conditions ...	Steam pressure 200 lb. per square inch, steam temperature 600 deg. F. Vacuum 2½ in. of mercury; normal speed 1,500 r.p.m.
Current generated ...	Three-phase, 25 periods, 2,500 volts.
Economical output of set	3,000 kw. at 0·85 power factor.
Maximum continuous capacity of alternators.	3,750 kw. at 0·85 power factor.
Momentary capacity of set.	5,500 kw. at 0·85 power factor.
Type of condensers ...	British Westinghouse surface condensers; cooling surface 8,250 sq. ft.; cooling water required, 6,800 gallons per minute, giving an absolute pressure of 2 in. of mercury with 45,000 lb. of steam per hour each and cooling water temperature of 80 deg. F.
Air and water extraction pumps.	Westinghouse Leblanc direct driven by 40-h.p. electric motors at 1,440 r.p.m.
Circulating water pumps	4 Gwynne vertical rotary pumps with Westinghouse motors, 240 h.p., running at 720 r.p.m., and each delivering 6,800 gallons per minute.
Purified water, bilge and emergency pumps.	Gwynne vertical rotary, driven by 13-h.p. electric motors running at 1,440 r.p.m.
Air exhausters	Gwynne air pumps.
Type of transformers in power station.	British Westinghouse three-phase, shell type, oil immersed, oil or air cooled.
Main step-up transformers.	Ratio 2,500 to 20,000; connections mesh-star; continuous capacity 4,860k.v.a.
Unit transformers ...	Ratio 2,500 to 440; connections mesh-star; continuous capacity 250 k.v.a.
Station transformers ...	Ration 20,000 to 440; connections mesh-star; continuous capacity 1,250k.v.a.
Lighting motor-generators.	British Thomson-Houston; 440-volt induction motor; 35-kw. direct-current generator; 10-kw. battery charging booster.
Engine-room crane ...	Babcock and Wilcox 40-ton crane with 5-ton auxiliary hoist span 60 ft.

The alternators are totally enclosed and ventilated by fans on the rotor which draw air from the basement through a dry air filter and discharge it outside the engine-room. The combination of an alternator and a step-up transformer as one generating unit permitted the actual alternator voltage to be selected so as to give the most simple and robust stator winding, the stator slots, which are completely closed, each containing only one conductor. The rotors are of the built-up plate construction with a distributed winding in slots, and are fitted with mild steel slip rings.

The step-up and unit transformers belonging to each generating set are housed in a separate chamber in the basement with hatchways in the engine-room floor through which they can be handled by the crane. The chambers are ventilated by fans which draw air from the basement, and provision is made for running off the oil from the transformers to the outside of the building in case of fire. Each step-up transformer has its own oil cooler through which the oil is circulated by a rotary pump driven by a 10-h.p., 440-volt, three-phase squirrel-cage motor. The unit transformers are air cooled. The station transformers are situated in separate chambers at the ends of the engine-room basement and are air cooled. An oil store was built on the power station site to contain the supplies of transformer and lubricating oil. An electrically operated oil-purifying outfit is used for filtering and drying the transformer oil after it has been in service for some months.

Condensing Plant.—The condensing water is taken from a pump-house on the River Lujan through two 27-in. diameter pipes about 500 yards long, and is discharged into a small creek somewhat nearer the power station, called the Rio Rosquetes. The condenser shells are cast-iron and the tube plates are rolled brass 1¼ in. thick. The tubes are ¾ in. external diameter and are of solid drawn copper of No. 18 S.W.G. Aluminium blocks are fixed in the water chambers in metallic contact with the tube plates. The air and water extraction pumps together with their driving motor are mounted on one bedplate. The circulating water-pump bodies are of cast-iron and the impellers are of gun-metal. The circulating water-pump motors are housed in a steel framed, corrugated-iron sheeted house erected on a wooden jetty projecting from the bank of the river. The site of the jetty was dredged before the wooden jetty piles were driven, and each pump is mounted in a tank so that its centre line is approximately at high water-level. The suction pipe is carried to such a depth as to ensure its being submerged in all states of the river. One side of the jetty consists of two screens of expanded metal arranged so that one screen at a time can be raised for cleaning. Flexible couplings are provided between the motors and the pumps to allow for settlement and straining of the jetty.

In addition to the main circulating pump motors, the jetty carries a centrifugal pump capable of delivering 300 gallons per minute against a head of either 20 ft. or 95 ft. This supplies water through a 6-in. diameter pipe, either to the purified water reservoir or direct to the storage tanks in the pump-house. Two motor-driven air exhausters are also located in the pump-house, each capable of producing in 3 minutes a vacuum of 20 in. in any one of the main pumps, including its suction pipe and discharge pipe up to the discharge valve. The main pump motors are started by means of oil-immersed auto-starters consisting of two separate single-phase transformers and the starting switch. Each motor is connected by a separate cable to one of the unit distribution boards in the power-house. Owing to the swampy nature of the ground between the river and the station it was not possible to lay the circulating water pipes direct in a trench. Instead they were erected on cross-bearers carried by pairs of wooden piles driven down to the tosca. The cables are carried on angle

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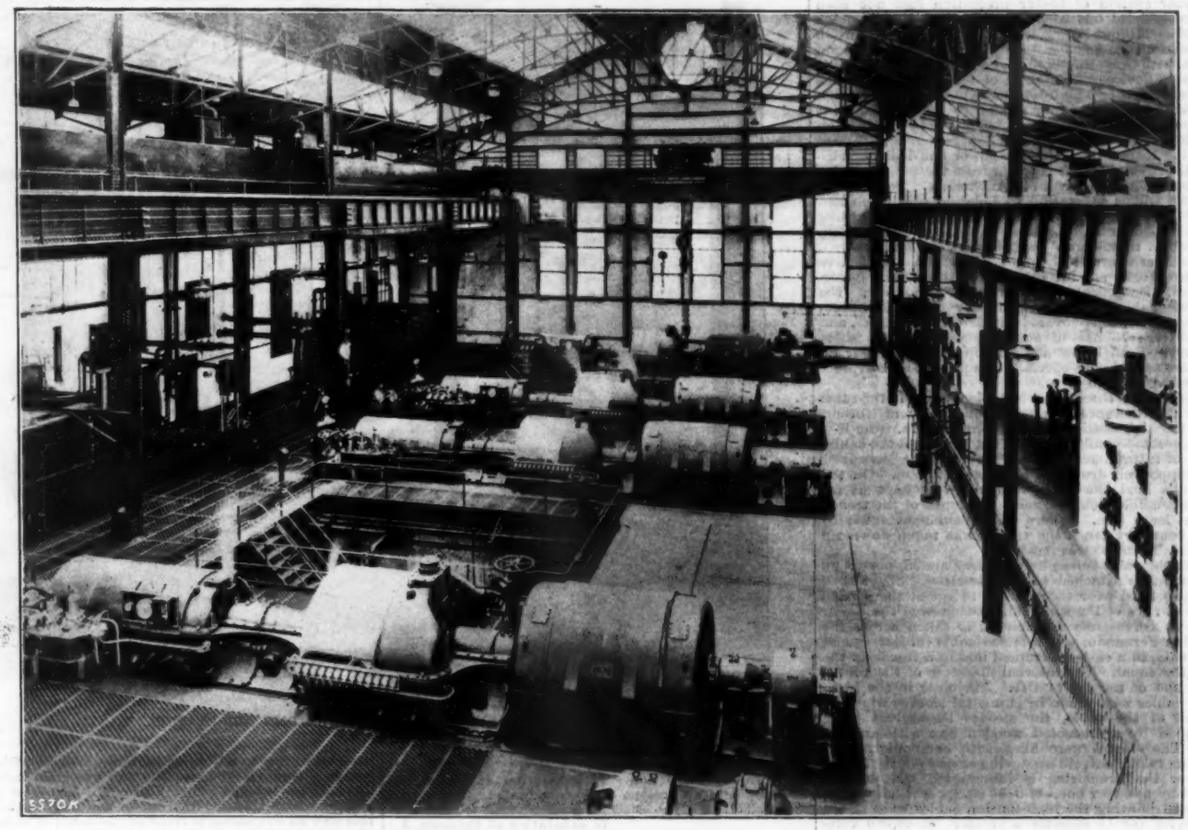

FIG. 5. TURBINE-ROOM AT CANAL SAN FERNANDO POWER-HOUSE.

irons supported from the cross-timbers. Where the inlet pipes cross the Rio Rosquetes they are carried on a steel girder bridge. The pipes, which are steel are lapped, with tarred Hessian tape.

Power Station Switch-gear.—All main switching is carried out at 20,000 volts. The main switchgear is located in a bay on the side of the engine-room opposite to the pump-house and boiler-house, the operating gallery being raised about 4 ft. above the engine-room floor so that the operator has a good view of all the machines. The generator panels, which are in the middle of the gallery, are set round a recess so that all the instruments and gear can be seen from one position. The station transformer and feeder panels stand on either side of the generator panels parallel to the axis of the engine-room.

Each operating panel consists of two cast-iron plates built into a wall of moulded concrete, 11 ft. high, faced with glazed tiles. This wall is set forward 3 ft. from the main panels and at the back carries the auxiliary wiring which is run as vulcanised india-rubber cable on porcelain racks. In the case of the generator panels the instruments (of the edgewise pattern and comprising an ammeter, voltmeter, power factor meter, and indicating wattmeter), are mounted on the wall above the upper cast-iron plate. Below them are the red and green indicating lamps which show whether the oil switch is closed or open. The upper cast-iron plate carries the oil switch operating handle, and interlocked with it, the handles controlling the cable and bus-bar isolating switches. Below the oil-switch lever are the automatic trip coils, and above it the time limit fuses. The voltage regulator is mounted on the wall to the left of the plate. The bottom plate carries the integrating wattmeter, the exciter field switch, the governor control switch, and the change-over switches for the voltage regulator and the ammeter. In front of each generator panel is a pedestal carrying the exciter ammeter and voltmeter and the hand-wheel which operates the exciter field rheostat mounted on an intermediate floor in the basement. A second pedestal carries the transmitter of an electrically operated telegraph by means of which the switchboard attendant can communicate with the driver when synchronising. Similar instruments mounted at the front of the gallery give communication with the boiler-house.

The main panels are formed of moulded concrete cubicles 5 ft. wide; the main wall is 9 in. thick and the sides of the cells are 4 in. thick. Intermediate floors, 4 in. thick, separate each cubicle into five storeys, which (starting from the bottom) are occupied as follows:—

(*a*) Potential transformers, (*b*) cable isolating switches and current transformers, (*c*) oil switch, (*d*) bus-bar isolating switches, (*e*) bus-bars. The different compartments are protected by screens of expanded metal interlocked with the main switch so that they can be opened only when the switch is open. The whole structure was moulded in position, the holes for the apparatus being cored out so that no cutting of the work was required. Porcelain only is used for insulation and in general, connections are made with bare copper, a minimum spacing of 15 in. between phases and to earth being adopted; where there is risk of conducting fumes causing short circuits the leads are covered with porcelain tubes. Small wiring in the cells is kept down to a minimum, and is run as rubber covered cable on porcelain cleats.

The three phases of each high-tension switch are contained in one tank which is built up of wrought-iron plates with special stiffening channels to take care of the maximum pressure generated in the tank when the switch opens on a fault. A vent pipe leads from the top of the tank to the outside of the switch cubicle to carry off any gases that may form. The leads to the switch terminals are introduced into the tank through cast-iron "U" bends filled up solid with compound. Provision has had to be made for the expansion of this compound in hot weather, otherwise the bends or porcelains are liable to crack. The current transformers are compound filled and ironclad. They are of two types, one suitable for mounting against a wall, the other passing through the floors between the compartments of the panels. The use of the latter saves floor insulators and economises space. On the generator panels current transformers are provided for the instruments, the protective devices and the voltage regulators. The potential transformers are oil immersed and self-cooled. Isolating switches and fuses are installed between them and the cable terminals so that a faulty transformer can be isolated from the rest of the switch gear. Permanent testing bus-bars are provided in the generator panels, connection to the main switch being made by removable jumpers. A water resistance was provided for taking the load of a generator under test; it consisted of three sets of wooden tanks mounted on insulators and with a partition down the middle. The water passes up one compartment and down the other, leaving the tank at the end at which it entered. The dimensions of each tank are:—

Length of water column, 6 ft.
Width of water column, two columns each 9 in. wide.
Depth of water column, 1 ft. 6 in.

The leads are attached to plates slung from a carriage which can be moved along the tank to regulate the load on the generator. During the tests on the machines considerable difficulty was experienced in preventing the sides of the tanks from charring.

The unit distribution boards are built up of enamelled slate panels and have the bus-bars mounted in front; porcelain handle fuses connect the bus-bars to studs which pass through the slate to the motor leads at the back. The oil switch controlling the feeder cable from the unit transformer is mounted at the back of the panel along with the current transformers for the trip coils and instruments. Bus-bar isolating switches are mounted on the front of the incoming feeder panel. The main motor distribution board is of slate panels similar to the unit distribution board. It is surrounded with expanded metal to prevent articles from falling on it from the engine-room floor above. Feeders are run from the station distribution board to the station auxiliaries and also to the unit distribution boards so that the latter can be made alive when a supply is not available from the unit transformers, *e.g.*, when starting up or shutting down a generator. In order to avoid any risk of paralleling a generator out of phase through its unit transformer the switches on the two feeders to each unit distribution board (viz., from the unit transformer and the station distribution board) are interlocked so that only one can be closed at once. They are also so arranged that the change-over from one supply to the other can be so quickly effected while the auxiliary plant is running that there is no appreciable drop in the speed of the motors. At each end of the switchboard gallery is installed a 110-volt direct-current board to control the supply from the lighting motor generators to the lighting circuits and the batteries. Two 250 ampere-hour Tudor batteries provide current for the indicating lamps on the main switchboard, the trip coils of feeders, electric telegraphs and a stand-by to the lighting system. The end cells of each battery are cut in or out of circuit by a solenoid operated remote controlled regulating switch. The switchgear in the jetty pump-house consists of

seven ironclad switch panels. The protective gear used for all high-pressure apparatus in the power station and on the system is of the Merz-Price type. Low-tension panels with oil switches are equipped with overload trip coils and time-limit fuses.

Cables.

When the scheme was under consideration the split conductor system of feeder protection had not been sufficiently tried out to justify its adoption in foreign work of such importance. Accordingly the high-tension transmission system consists of 20,000-volt underground feeders, with three simple cores, and of pilot cables for the protective devices. A system of telephone cables was also installed. Two high-tension cables are laid through the streets from the power station to the nearest point of the electrified railway track. Then they run, one on each side of the line, to Olivos substation, the western one being looped into Victoria power and lighting sub-station. A third feeder is taken from the power station to Olivos along the track *via* Anchorena. Two feeders run from Olivos substation to Palermo substation and two from Palermo substation to Retiro power and lighting substation. The high-tension cables are 0·1 sq. in. in section, three-core, paper-insulated, lead-covered, single-wire armoured; the pilot cables for the protective gear are 0·005 sq. in. in section, three-core, paper-insulated, lead-covered, single-wire armoured; the telephone cables are eight-pair, dry core, air-spaced, paper-insulated, lead-covered, single-wire armoured, and suitable for the use of superimposed circuits where necessary. Both below and on top of the armour all cables are served with specially-compounded waterproof preservative coverings.

In general the three types of cable are laid in the same trench at a distance of about 1 in. from each other. Above the high-tension cable and about 4 in. from it is laid a creosoted plank, 8 in. by 2 in., to protect the cables in case of future excavations. The high-tension cables were shipped on drums in lengths of 100 m. On the company's land the cable trenches were kept as far away as possible from the rails, the depth of the trench being at least 1 m. Where an embankment extended to the boundary fence the trench was taken down till undisturbed ground was reached.

Where the cables cross bridges they are supported on cast-iron racks attached to the structure. Sheet steel covers are fixed over the troughs to shield them from the direct rays of the sun. The feeder from the power station to Olivos, *via* Anchorena, is taken across the Canal San Fernando, which is navigable for barges and small boats, in a cast-iron tunnel laid in a trench in the bed of the canal. The internal diameter of the tunnel is 3 ft. and of the shafts 4 ft. All joints in the high-tension cables were made in gunmetal sleeves wiped to the lead of the cable, the sleeves themselves being surrounded by a creosoted wooden box with an iron cover. The sleeves were filled with compound, great care being taken to avoid producing cavities in the filling. Wherever the armouring is interrupted the joint is spanned by a copper bond of 0·05 sq. in. section. After laying and jointing the high-tension cables were tested by applying for 15 minutes a pressure of 40,000 volts between any core and the lead and between any two cores. The direct-current feeders from the substations to the track and the jumpers spanning gaps in the conductor rail are of 1 sq. in. section, paper-insulated, vulcanised bitumen sheathed, taped and braided. They are laid solid in Key's fibre conduit filled with Trinidad bitumen. The conduits are 4⅜ in. external diameter and about 5 ft. long, the joints between conduits being made by fibre sleeves. The cables are supported in the conduits by fibre bridges. A creosoted plank is laid over the conduits.

The telephone system installed in connection with the electrification works provides communication between the power station and the substations, the car sheds and the signal cabins in the electrified area. Twenty-two wire exchanges of the Stirling automatic type are installed at Victoria and at the power station.

Traction Substations.

The line at present electrified is served by three traction substations situated respectively as follows:—

San Fernando substation, about 1½ miles from the outer end of the line.

Olivos substation, about midway along the line.

Palermo substation, about 2½ miles from the city terminus (between Palermo and the terminus four tracks are equipped electrically).

The buildings are all of the same general design (Fig. 6), being steel-framed structures walled with brick covered with armoured cement plaster. The floors and roof are concrete reinforced with Clinton fabric, the roof being flashed with ¼ in. of rock asphalt. Palermo substation is surrounded by a public park and the Government consequently called for a more ornate structure than was required for the others. Provision is made at the substations for housing the attendants. Each building is divided into three main aisles, the centre one containing the rotary converters and transformers and the side ones containing the high-tension and direct-current switchgear respectively. There is a loading bay at one end into which a siding comes, so that railway trucks can be brought under the overhead crane which traverses the whole building. Provision is made for extension of the building at the end away from the loading bay, when it is necessary to install further converter sets. The basement contains the main transformers, the potential and current transformers, the high and low-tension feeders, rotary field rheostats, the lightning arresters and battery. On the first floor are situated the rotaries, the 800-volt switchgear, a motor generator, and on a raised gallery, the high-tension operating gear.

ELECTRIC TRACTION; CENTRAL ARGENTINE RAILWAY.

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Fig. 6. Rotary Converter at Palermo Sub-Station.

Table IV.—*Details of Plant in Traction Substations.*

Number of rotary converter sets at present installed.	In substation at Canal San Fernando, 3. In substation at Olivos, 3. In substation at Palmero, 3.
Type of rotary converters.	British Thomson-Houston Co.'s; compound wound; communicating pole; six-phase diametrically connected.
Output of rotary converters.	1,000 kw. at 800 volts, normal rating; 1,500 kw. for 2 hours; 2,000 kw. for 10 minutes; 3,000 kw. momentarily.
Type of rotary converter transformers.	British Westinghouse Co.'s; single-phase; oil immersed; naturally cooled.
Capacity of transformers	375 k.v.a.
Type and capacity of station transformers.	British Westinghouse Co.'s; three single-phase, oil-immersed; naturally-cooled; each of 20 k.v.a. capacity; ratio of transformation, 20,000 volts to 440 volts.
Type and capacity of station lighting transformer.	British Westinghouse Co.'s; one single-phase; oil-immersed; naturally-cooled; 10 k.v.a. capacity; ratio of transformation, 440 volts to 110 volts.
Type and capacity of motor generator.	British Thomson-Houston Co.'s; 5 kw. capacity; alternating-current voltage 440; direct-current voltage 110.
Type and capacity of air compressor.	Alley and McLellan; 39 cub. ft. of free air per minute at a pressure of 60 lb. per square inch.
Type and capacity of ventilating fans.	Blackman; 25,000 cub. ft. of air per minute.
Type and size of secondary battery.	Tudor Accumulator Co.'s 50-ampere hours.

The high-tension gear is similar to that in the power station; the bus-bars are sectioned and interconnected by an oil sectioning switch, the two halves of the bars being fed by different cables.

The direct-current switchboard is built up of panels supported on a pipe framework. A single-pole circuit-breaker with overload and reverse current tripping coils, and a knife switch, which isolates the circuit-breaker from the bus-bars, are mounted on a marble panel at a height of about 8 ft. from the floor. Marble partitions between adjacent panels form separate cubicles and prevent the arc from a breaker which opens on a fault from travelling to adjoining switches. The switches are operated through wooden rods and porcelain insulators by handles which project through cast-iron panels mounted about 14 in. in front of the marble slab. In this way all live metal in front of the board is placed out of reach of a person standing on the floor. The generator panels carry hand-wheels for operating the rotary field rheostats which are mounted in the basement directly below the board. Differential relays are provided to prevent a circuit-breaker being closed when the polarity of its rotary is reversed. These operate in conjunction with indicating lamps which light up in such circumstances.

Table IV gives particulars of the principal plant in the traction substations. The rotary converters (Fig. 6) are self-synchronising and are started from tappings on the low-tension side of the transformers by an oil-immersed controller. Provision is made for coupling negative boosters to the ends of the shafts when the traffic increases to such an extent that the drop in the track rails becomes higher than desirable.

Special precautions have been taken to reduce to a minimum the flashing over which is liable to be caused by heavy short circuits on the track. With this object the commutator cones have been covered with projecting fibre sleeves, and all earthed metal near the commutators has been painted with a composition made up of half gold size and half linseed oil. In addition, screens are fixed between the brush holders to prevent flashing round the commutator. By these and other means the number of flash-overs was reduced from an average of six per month during the first six months of operation to an average of two per month for succeeding months.

The transformers are mesh-connected on the high-tension side, with tappings on the high-tension side to compensate for variations in the supply voltage and on the low-tension side for starting. The tanks are ¾-in. boiler plate with external tubes to give increased cooling surface. They are mounted on rollers so that when the core has been lifted by the overhead crane the tanks can be run out of the chamber and the core set down on a drip tray for examination. The chambers are ventilated by ducts carried up to the roof to Barrol ventilators; cooling air is drawn from outside the station by motor-driven fans and passed round the foundations of the converters into the transformer chambers through an expanded metal opening in the door. The auxiliary equipment of each substation includes a bank of three single-phase transformers which gives a supply to the motor generator, air compressor used for cleaning purposes, ventilating fans, and the lighting transformer. The motor generator gives a direct-current supply at 110 volts for charging the battery used for the tripping and indicating circuits and emergency lighting.

Negative Bus-bar Pilots.—In Olivos substation a panel is installed carrying two centre zero voltmeters connected

to pilot wires running to the negative bus-bars of the three substations. A permanent deflection of one of the pointers indicates to the substation attendant that there is a difference of potential between the bus-bars in two adjoining substations, and that one substation is "motoring" the other. He can then instruct one of the substations to raise or lower its voltage of supply till it is taking its proper share of the load and the transference of current ceases.

Power and Lighting Equipment.

Two substations are provided in the electrified section to give a supply for general purposes, one situated at the Retiro terminus and the other at the Victoria workshops. The former is designed to deal with the power and lighting requirements of the terminal station, train yard and offices, and to give a supply for pumping and for operating the compressors of the pneumatic signalling system; the latter supplies power and light to the workshops, locomotive sheds, car sheds and repair shops at Victoria Station. Details of the principal apparatus are set out in Table V.

Table V.—*Details of Plant in Power and Lighting Substations.*

Retiro Substation.

Type and output of motor generators.	British Thomson-Houston Co.'s; asynchronous 440-volt motors; output 400 kw. at 240 volts direct-current.
Type and capacity of step-down transformers	British Westinghouse Co.'s; three-phase; oil immersed; naturally-cooled; 600 k.v.a. capacity; ratio of transformation, 20,000 volts to 440 volts.
Type and size of secondary battery.	Chloride Electrical Storage; 4,000 ampere-hours; capacity at 240 volts.
Type of battery regulating switch.	Bertram Thomas.

Victoria Substation.

Type and capacity of transformers.	British Electric Transformer Co.'s, Berry type; three single phase transformers; 375 k.v.a. capacity; ratio of transformation, 20,000 volts to 440 volts.

Retiro substation has a frontage on the Paseo de Julio, and the external elevation has been designed to be in keeping with its location; internally the design is similar to that of the traction sub-stations. Space is reserved in the station for two traction rotary converters which will be installed when the goods traffic in the yard and at the docks is handled electrically. The high-tension switchgear is similar to that in the traction substations; the direct-current board consists of slate panels supported on a pipe framework. Battery-charging boosters are mounted on the bedplate of the motor generators and direct-coupled to the armature shafts. A battery-regulating switch of the single-sided remote-control type is installed to control the end cells of the lighting battery.

The Victoria substation is a small building containing two banks of transformers with the necessary high-tension switchgear and low-tension panels. The high-tension switchgear is of the standard type; the low-tension board consists of slate panels mounted on pipe framework with expanded metal screens enclosing the back of each panel. The low-tension feeders are run from the sub-station as overhead lines.

The lighting of wayside stations along the electrified track is taken from the third rail, the circuits being arranged to take six 100-volt lamps in series. Vulcanised-bitumen sheathed, paper-insulated cables of 0·1 sq. in. section are taken from the third rail and track rails respectively to a "casilla," a small brick chamber, in which the switches are housed. The main panel is of slate and carries a single-pole knife switch operated by a handle which projects through the panel, a fuse and a voltmeter. The circuits are controlled by double-pole knife-blade switches, each circuit being protected by a double-pole fuse.

(To be continued.)

Coal Deposit Survey in Queensland.—The Queensland Government Under Secretary for Mines in his report for 1917 says that the principal work for the year of the Chief Government Geologist was a close investigation of the coal available in the Bowen coalfield. As a result of a previous geological examination there was selected, as a State mine reserve, an area 1¼ sq. miles in extent, within which a number of bores were sunk. These bores disclosed seven seams of coal, varying in thickness up to 13 ft., and of these seams five are considered to be of workable thickness and quality. A total of coal content has been proved of 46,000,000 tons, of which 22,000,000 would be actually available. The Bowen seam is the principal one of the field, and from the seam alone 12,000,000 tons are available within the reserved State area. Outside the State reserve an adjoining leased area has since been proved by the same methods as those adopted on the reserved land, the boring being carried out on sites selected by the geologist; and within these two areas it is estimated that the Bowen seam alone would yield 50,000,000 tons of coal, irrespective of any other seams or any other portions of the field outside those areas. As a result of this estimate of coal quantities, no hesitation was felt in strongly recommending the construction of a railway to connect the field with Bowen.

"COAL SAVING BY SCIENTIFIC CONTROL OF STEAM BOILER PLANT."

To the Editor of Engineering.

Sir,—I did not intend taking up any more of your valuable space on this subject, particularly when Mr. Brownlie did not suggest pursuing the matter beyond the generation of the steam at the boiler-house, but when your anonymous correspondent "Get a Move On" writes in the style he does, I feel that one should draw attention to the wholesale condemnation "in his estimation," of all of the other correspondents.

I suggest, Sir, that he has gone a bit too far with his letter. Some of us, no doubt, are mere nothings in the engineering world, but I notice that we remain still the same few people who have been taking this subject of fuel economy very seriously for some time past, voluntarily spending much time and money on so doing, without the slightest idea of any recompense. Surely under these circumstances a little more professional etiquette should be practised. Two heads are better than one, and it is this co-operation of suggestions where one is just liable to pick up a thread of others' ideas and make it possible to proceed on some better mutual line.

What does "Get a Move On" suggest; nothing but that which has been suggested by other people. The only good point I can pick out, if I may be allowed to repeat it, is where he says "Anything which is an innovation is received with scorn by the powers that be." I suppose he must be one of the "powers that be," because he treats our letters with such wholesale scorn, when we suggest that there is much more in coal than the mere calorific value.

I admit that given a plant that is designed right, that the addition of a few scientific tell tales are an advantage, but even then too much is left to the stoker. If he so wills it, or is lacking in knowledge of the elementary rules of combustion, no recording instrument would prevent this. Spend a few hours in the boiler-house and teach him.

I question even to-day if it is possible to get a satisfactory temperature in Lancashire tubular furnaces to have perfect combustion; by having a greater quantity of water over this part would then add to the difficulty.

The better combustion in watertube boiler furnaces is no doubt due to the fact that the gases get a chance of this higher temperature before they reach the much colder steel or other metal composing the heating surface, due to the large area of firebrick in the furnace. The same thing applies to most of our domestic fireplaces. Most of the problems of coal combustion and steam generation have been scientifically thrashed out many, many years ago by pioneers such as Prideaux, Williams, Box and many other later men, and they have produced ideas which we have neglected to put into practice simply because our coal was far too cheap and too abundant so that the burning of a bit extra fuel was nothing in comparison to the work entailed and little extra capital expenditure of the plant. But apart from this let me put one or two things before your correspondent which I have had before the public for a long while, and never received an answer yet.

We are working, and have been for many years, the seams of coal that were and are the easiest to mine, which before many years are over will be exhausted, thus leaving us only the thin seams, more difficult to get, more dangerous to the men and also a probability of a temperature in the place that may be unbearable and where ventilation of the place may be a problem. As much more than coal will be brought away from these thin seams, this will put a further charge on the washing of the material and preparing it for market. This will reduce our means of competition with such a place as Germany, for instance, where there are many seams of easily procured coal yet to be obtained, much more than we ever had.

Pause over this; there is no doubt the wealth of this nation depends on its coal to create cheap power, &c., yet we still go on in the same happy-go-lucky way in using it, because it is cheap and supposed to be plenty for ever and a day.

Many cargoes of German coal came to the Thames just before the war; if they could compete with us then, when we still have easily procured coal, what will they do when our thicker seams are worked out. Not many years ago there were two seams of coal in Lanarkshire, both 6 ft. thick, one over the other. The prevailing idea was that this coal would last for ever, both were of an excellent nature and one of them, the Splint seam, so influenced the design of the iron furnaces that they could use the raw coal without coking it. To-day, both seams are practically worked out, and iron furnaces have to depend on much thinner coal of inferior quality.

Again, look at the various concerns throughout the country, each having a residue which is a nuisance to them and is that which another requires as an initial manufacture.

Might I mention Coalite; when this was originally introduced (many years too early for most of our brains), they had to run pipes to the middle of a field to get rid of the gas by burning, when in the towns close by they wanted gas, and the coke they had left was a nuisance to them. The same thing applies to many of our so-called modern gas and power generation plants to-day in combination with coke oven, coke-making.

Firms of Continental recovery plant advertised quite openly that they were prepared to erect and maintain, free of cost, and guarantee a greater output of coke for a number of years, if the colliery people would let them have the by-products—I think, for three years, but am not certain—after which the plant and by-products would become the property of the colliery. Surely this is a proof that we have been asleep in this trade.

Again, after everybody has had a nibble at the coal in their own sweet old-fashioned way, someone tries to block up our railways, rivers and canals (not mentioning too much the streets) with units of transport the size of which did credit only to our forefathers in the good old days of horse transport.

"Get a Move On" has mentioned American method of coal conservation, perhaps he may be interested to know that they encourage novel suggestions over there, they don't try to scoff at any idea. I possess several letters from many of the States committees, including their chairman, and they are all greedy for further advice. I may add that I have learned a lot from them and also from several of their universities who make a speciality of coal and its economic use. This country could take many a lesson from the United States on this matter of educating the commercial undertakings.

I believe they are now using 80-ton wagons at places over there (2,000 lb. = l'ton), and it may further interest your correspondent to know that the only answer I have yet had regarding the increase of size of coal wagons in this country is that it would entail such a drastic alteration at the screens. Well, Sir, entail this drastic alteration, which probably means sinking the railway a bit, or putting a few bricks under each supporting column of the heapstead, if this isn't sufficient put a charge of dynamite under it together with many of our fossilised ideas, so that we can improve our country a bit.

There is just one more point, and I think I have the support of many of my colleagues in this matter, and that is, before anyone should constitute themselves a judge of others, he should come out in the open and let us know who he is; perhaps then he will be able to get out of the rut he is in, help others who gratefully acknowledge help, and at the same time get a move on himself to introduce some innovation in the coal and transport trade other than things suggested many years ago. He will then find that there are many men who have latent ideas, awaiting for a little encouragement, and then I shall be glad of his assistance.

I remain, Sir, yours faithfully,

John H. Anderson.

Purfleet, Essex, October 12, 1918.

To the Editor of Engineering.

Sir,—Why Mr. Brownlie's results of boiler tests show such low efficiency, may in part be gathered from the contents of a letter, I have just received from an under fireman, quite unknown to me, who has been following the discussion on the above subject in Engineering, the contents briefly are as follows:—

"I have seen your letter in Engineering at the library. I am an under-fireman, and I wish to say coal is wasted at our works because the charge man does not allow us to alter the feed of the stokers. We have to keep the steam blowing-off all the time and a lot of the coal drops over into the ash pit, at the end of the bars not half-burned and is pulled out with the clinker, and no matter whether the load be light or heavy, the stokers run at the same speed."

It is easy to understand that with such carelessness in feeding the boilers the same spirit will permeate the whole steam plant staff, wasted coal being the result.

I also have a letter from an engineer, who sends some readings from his CO_2 recorder taken by his ordinary fireman and with a scratch lot, 84 readings in each case checked every 15 minutes. With his ordinary attendants CO_2 averaged 14·5 per cent., say 16 lb. of air per pound of coal, but with the scratch fireman the average CO_2 was 7 per cent., which equals 333 lb. of air per pound of coal, and represents a loss of efficiency of approximately 17 per cent. as compared with the first-mentioned.

Why should we beat about for a cause of coal wastage any longer, the cause of wastage is principally excess air, and this is greatly minimised by reducing the area of fire grates until they bear a ratio of 2 to 1 to outlet from the furnace flues. Prevent coal shortage by stopping wastage.

Yours faithfully,

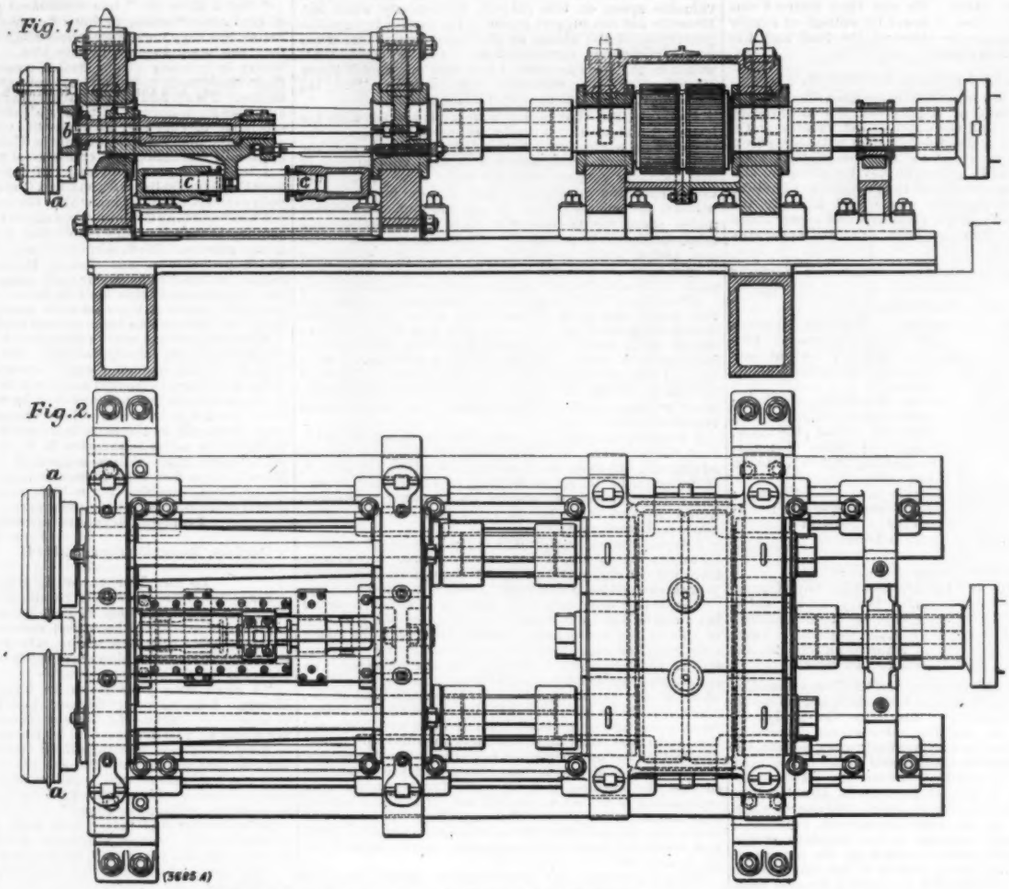
W. H. Casmey.

Milnthorpe, Wakefield, October 15, 1918.

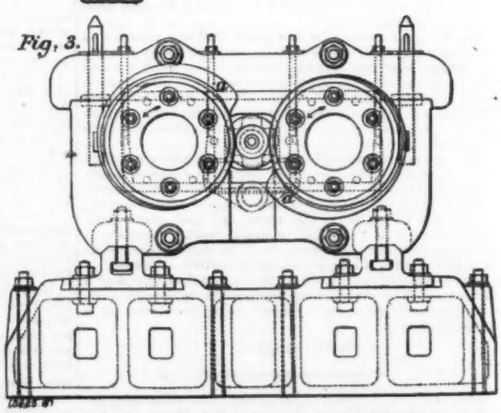
Road Maintenance.—The Army Council have appointed a committee to be called the Joint Roads Committee, for the purpose of carrying into effect the powers of control and maintenance in regard to public roads vested in the Army Council by the Defence of the Realm Regulations and of performing certain duties in connection with the construction, improvement and maintenance of such roads for war purposes. Brigadier-General Lord Montagu of Beaulieu has been appointed chairman of the committee by the Council.

Second-Hand Boilers.—The Minister of Munitions has ordered as follows: (1) No person shall, as from the 10th inst., until further notice, except under and in accordance with the terms of a permit issued under the authority of the Ministry of Munitions, purchase, sell, or otherwise deal in any second-hand steam pressure boiler of any type not being a boiler for use in any locomotive, motor car or vehicle, or on a ship or other vessel. (2) This Order may be cited as the Boilers (Control) Order, 1918. *Notice.*—All applications for permits may be obtained upon application to the Controller, Department of Engineering, Charing Cross Embankment Buildings, W.C. 2. A permit to deal generally as a second-hand boiler merchant may be granted to approved persons, and all applications for such a permit should be made to the Controller, Department of Engineering, Charing Cross Embankment Buildings, W.C. 2. Nothing in the above Order shall be deemed to authorise any dealing in any boiler for which a permit is required under the Railway Material (Second-hand) Order, 1916.

SLICK ROLLING-FORGING PROCESS AT THE CAMBRIA STEEL WORKS, U.S.A.



Figs. 1 to 3. Shears for Cutting Hot Rounds.



A very interesting process of producing wheels and discs by rolling is in operation at the works of the Cambria Steel Company, Pa., and is described in a recent issue of *The Iron Age*. The method, which is due to Mr. E. E. Slick, consists in cutting "cheeses" off 11-in. to 20-in. rolled bars and then converting these blanks into wheels or discs by a special form of rolling mill. These blanks are cut from the hot bar by the eccentric shears which we illustrate in Figs. 1, 2 and 3. The cutters *a*,*a*, are mounted on heavy discs keyed to 24-in. shafts which are geared together and rotate in the same direction, as will be seen from Figs. 1 and 2. The cutters, as best shown in Fig. 3, have cam-shaped edges which approach and recede from each other as the cutters rotate. It is this approach of the two edges during a rotation which effects the cut on a bar placed between the two by shearing.

A strong spray of water is used to keep the cutters cool when at work. The diameters of the discs on which the cutters are mounted varies somewhat with the diameter of the bar to be cut. For 11-in. bars it is 5 ft. 1 in. During the cut the bar rests for its full length on a live roller. Stationary guides keep the bar in position and guide it axially when it is fed forward after the cut. During the cut the forward end of the bar is supported in the steel cup *b*, Fig. 1. The position of this cup can be adjusted axially by means of the hydraulic rams *c*, *c*. Screwed stops limit the motion and allow the length of blank to be adjusted with very great accuracy, successive blanks being almost precisely identical in weight. The time required for a cut is 8 seconds, and the machine is of a most massive character. It measures 36 ft. in length by 18 ft. in width, and is 13 ft. 6 in. high above foundation level, the total weight 850,000 lb. The feed table is 60 ft. long.

When the cut is finished the cup *b* is moved to the right and the central rod shown then pushes the blank clear, and it falls into a car or other receptacle below. The blanks are next re-heated and are then punched so as to leave a hole nearly half-way through them. Into this hole a loose pin or mandrel is fitted which serves to centre the blank in the subsequent rolling operation. This is effected in the mill shown in Figs. 4, 5 and 6.

It consists essentially of two shafts set at a slight angle to each other, as best seen in Figs. 4 and 5. At adjacent ends each shaft carries a die corresponding to the wheel form required, and between these dies the blank is placed. One die is fixed axially, but the other can be traversed axially by hydraulic rams *e* and *f*. The main ram has a diameter of 38 in., and works under an hydraulic pressure of 3,000 lb. The tail rod is 18 in. in diameter and is fitted with a massive nut which limits the forward motion of the head. A lower pressure of 500 lb. per square inch is used in the pull-back cylinders *f*, *f*. The total thrust exerted by the main rams is about 3,000,000 lb., and a roller thrust bearing is used to transmit this thrust to the die. This bearing is 4 ft. 8½ in. in diameter and is illustrated in Figs. 7, 8 and 9.

Two 13-in. tie rods *g*, *g*, Fig. 5, hold the opposing die up to its work, the pull being transmitted through a similar roller bearing to that used on the sliding head. The mill is motor-driven, the motor being mounted on top of the moving head as shown in Figs. 5 and 6. This motor drives the die shaft through reduction gearing at 100 r.p.m. The power taken is between 1,000 h.p. and 2,000 h.p. The time required for the rolling operation is 20 seconds in the case of small wheels and about 1 minute for the largest sizes. The blank is purposely made a little large so as to ensure in all cases a slight surplus of metal, which is rolled into a thin fin and is sheared off in a subsequent operation. The rolling mill is 40 ft. long, 18 ft. wide and 14 ft. high, and weighs without motor or driving gear 400 tons.

A pusher bar forces the wheel out of the die as the pull-back cylinders retract the rolling head. Subsequent operations include the removal of the fin of surplus metal left round the rim and the through punching of the central tube.

An advantage claimed for the process above described is that the wheels are of uniform texture on the run, whilst if rolled from blanks punched out of slabs the grain varies from point to point, owing to the fact that the grain of the original slab differs according as a section is taken parallel or transverse to the original direction of rolling. Again, any piping or porosity which may have existed in the centre of the round bar used in the Slick process remains in the centre of the punched wheel, and is thus removed when the wheel is pierced to take the axle. Amongst the products of the mill may be mentioned blanks for gear wheels and standard car wheels for main line suburban and tramway rolling stock from 21 in. up to 38 in. in diameter.

Iron and Steel Prices.—The Director of Iron and Steel Contracts has modified, as from October 1, the schedule of steel prices appended to the Order of November 30, 1917, and a fresh Order to this effect will be gazetted shortly. The alterations cover maximum prices and extras, which apply to steel slabs, plates, sheets, strips, &c. All communications with reference to the Order should be addressed to the Director of Iron and Steel Contracts (Room 104), Ministry of Munitions of War, 8, Northumberland-avenue, S.W. 1.

SLICK ROLLING-FORGING PROCESS AT THE CAMBRIA STEEL WORKS, U.S.A.

(*For Description, see opposite Page.*)

Fig. 4.

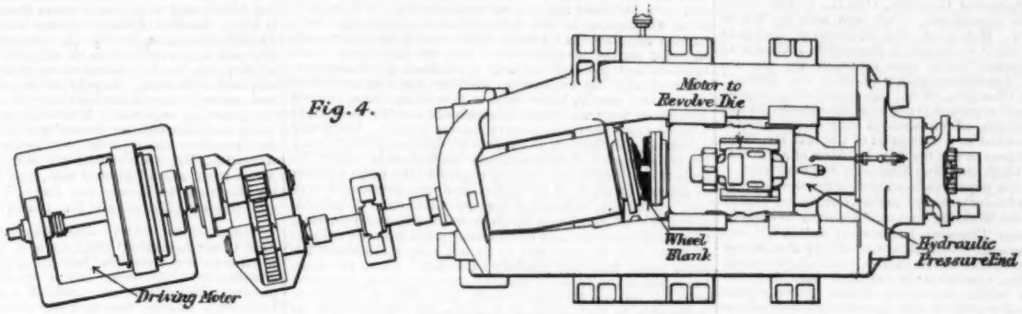


Fig. 5.

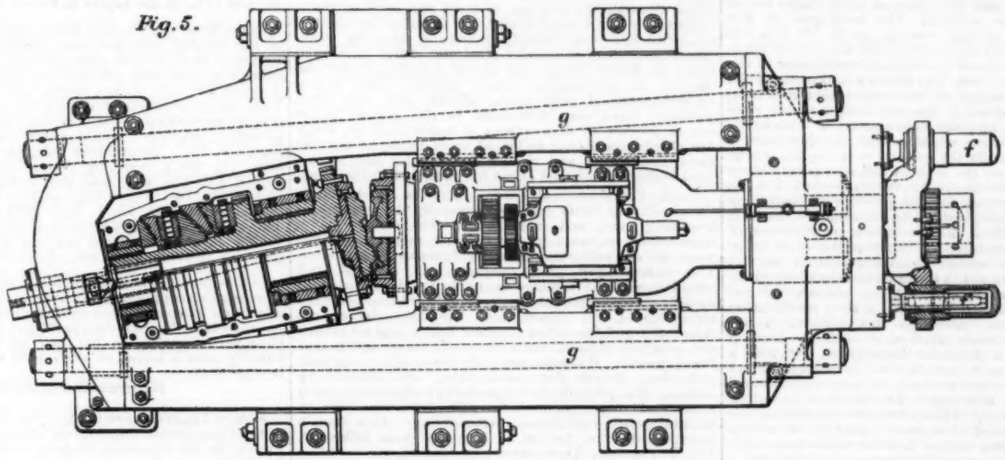


Fig. 6.

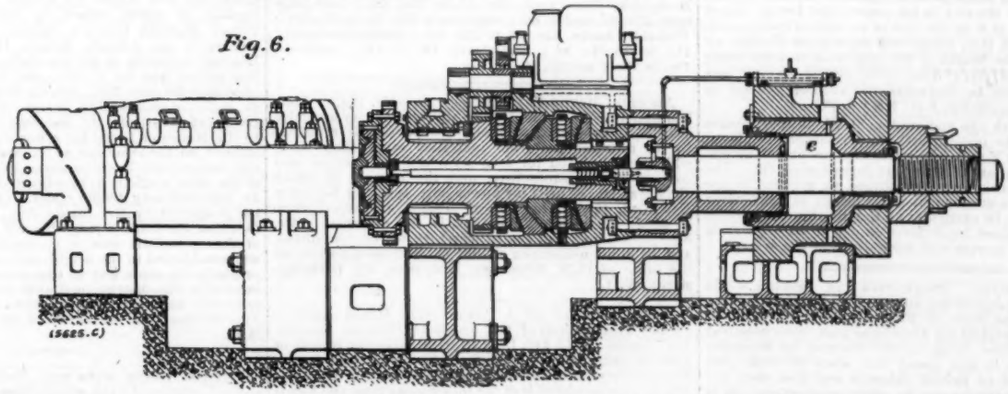


Fig. 8.

Fig. 9.

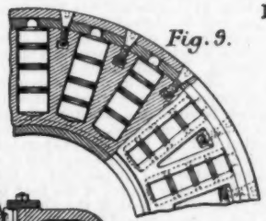
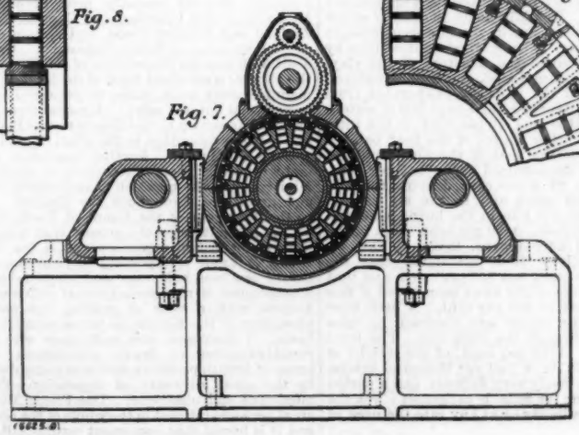


Fig. 7.



FIGS. 4 TO 9. ROLLING-FORGING MILL FOR WHEELS.

TIME TAKEN IN BUILDING STANDARD STEAMERS.—The following list shows the time taken in the construction of some of the various types of ship which were completed in this country during September:—

"A," "B" and "E" Types.

Yards.	Type.	Time from Laying Keel to Launching.	Time from Keel Laid to Completion.
		weeks	weeks
Belfast	"B"	34	35
Sunderland ..	"A"	29	37
West Hartlepool ..	"E"	31	40
Stockton	"B"	33	46
Sunderland ..	"A"	36	46
Sunderland ..	"B"	39	56
Dundee	"B"	47	56

These three types of standard ships are very similar. Their chief features are:—"A" and "B" types—length, 400 ft.; breadth, 52 ft.; depth, 31 ft.; draught, 25 ft. 1 in.; indicated horse-power, 2,850; speed, 11½ knots; tonnage, 5,150 gross, and dead-weight, 8,200 for the "A" and 8,100 for the "B" type. For the "E" type the particulars are:—Length, 376 ft.; breadth, 51 ft. 5 in.; depth, 29 ft.; draught, 23 ft. 9 in.; indicated horse-power, 2,850; speed, 11½ knots; tonnage, 4,400 gross, 7,000 dead-weight.

THE OPTICAL SOCIETY.

At a meeting of the Optical Society, held at the Imperial College of Science and Technology, on October 10 the president, Professor Cheshire, C.B.E., in the chair, two papers were considered. The first was by Naval Instructor T. Y. Baker of the Admiralty Compass Department, on the "*Sources and Magnitude of Centering Errors in a Sextant*," and was followed by one on "*Astigmatism: Interchangeability of Stop and Object*," by Mr. Theodore Chaundy, M.A. An interesting present to the Society was reported from Miss Elizabeth Payne, F.S.M.C., of Oldham, of an ancient pair of eyeglasses. The gift was intended as a memorial of the late Dr. Wm. Ettles, past president of the Society, in token of appreciation of his great skill, unfailing kindness, and courtesy.

Mr. Baker, in his paper, showed that a centering error in a sextant is ordinarily due to the sextant being placed eccentrically on the dividing engine. In order to comply with the National Physical Laboratory's "A" Class certificate it is necessary that this eccentricity should not be such as to produce errors in the reading exceeding 40 seconds. This condition is satisfied provided the scale centre lies within a certain ellipse whose centre is the mechanical centre of the instrument and whose axes lie, one along and the other at right angles to the line of the middle reading. The semi-axes of this ellipse for a 7-in. sectant reading up to 120 deg. are 5·2 mils and 0·7 mils respectively, but the former figure needs reduction to about 3 mils in order to allow of the vernier not reading "long" at the two ends of the scale. The customary practice of sextant makers has been to readjust the position of the mechanical centre after the instrument has had the scale engraved. The workshop method of testing whether such readjustment is necessary is customarily the method of trying the length of the vernier against the scale at different points along the arc. The author showed that this method is not a sufficiently delicate test for the purpose of complying with the "A" certificate. An alternative method was described in which the correctness or otherwise of the centre is determined by the tracing of a mark engraved upon the vernier against a circular arc cut from the same centre and at the same time as the marking of the scale. This method is being adopted by the Admiralty, and is already embodied in their specification for cadets sextants. Although this method is not completely good enough when used with the reading microscope which is fitted to the sextant, yet with a higher magnification it promises to be successful and should enable the sextant maker to adjust the mechanical centre so that the instrument has no error exceeding the 40 seconds allowed. The author also called attention to the very great need of improved methods of setting sextants on a dividing engine in order to do away with the necessity for subsequent readjustment of the centre.

Mr. Chaundy showed in his paper that for an object at O and a stop at S on the axis of an optical instrument, the astigmatism (*i.e.*, astigmatic separation divided by the square of the height of the object) is to least order $f^{-1}(1 - FO \cdot FS/f^2)/\xi^2 SO$. The planes of stop and object may thus be interchanged without change in value of the astigmatism $FO \cdot FS = f^2$.

In this case, with like end media, F′, S′, O′ (the images of F, S, O in the instrument) are symmetrically placed with respect to F O S. In particular an object at one focus and a stop at the other are interchangeable. The astigmatism in this case is unaltered by reversal of the instrument; its consequent convenience in calculation is pointed out. In particular all the primary aberrations may be determined by differentiation of its expression in terms of the powers and separations of the system.

British Mining Properties in Brazil.—His Majesty's Government are informed that various mining properties in the State of Mines Geraes, Brazil, which have not been worked for some time past, have acquired an enhanced value owing to the demand for Brazilian manganese. It is also stated that some of these properties belonged to British subjects and that they are now being trespassed upon by other prospectors. It is suggested that any British subject desiring to preserve their rights should communicate with Messrs. Nicolson and Co., Limited, 6, East India-avenue, London, E.C. 3, who have handled business of this nature for some years past and who have been good enough to undertake to do what they can to assist British owners of such properties. Applicants should furnish their title deeds and the fullest possible particulars of their rights to Messrs. Nicolson, who have been supplied with all the information in the possession of His Majesty's Government.

Fabricated Ships.—The first of the national fabricated ships, which was launched on August 8 from the Wallsend yard of Messrs. Swan, Hunter and Wigham Richardson, Limited, was completed on September 28—just 31 weeks from laying of keel to completion, a very fine record. She is the pattern vessel, from which many others are being built on the fabrication system, with the aid of bridge-building firms. She is 411 ft. 6 in. long, 55 ft. 5½ in. broad, 38 ft. 1½ in. deep, and has a deadweight carrying capacity of 10,500 tons on a draught of 28 ft. 3in. Bridge builders being unable to deal with curved surfaces, she is built on a "straight-line" form. There is not a single bent frame in the ship, and all the plating, with the exception of some at the fore and aft ends, is straight. Another vessel, 6,500 tons gross, of almost the same model, but still a new type, designed by Sir W. G. Armstrong, Whitworth and Co., has just been launched from that firm's Low Walker yard. She is the first of a series the firm is building, constructed on the Isherwood system of longitudinal framing.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—The German appeal for an armistice, and the probability of an early cessation of hostilities has been the chief topic in all trade circles. While there is no slackening in the production of munitions, firms having large stocks on hand which would drop seriously in value on the termination of war are displaying great caution and general trading operations are disturbed. Most of the big contracts, whether for raw materials or finished goods, have clauses providing for a sudden ending of war, while all Government contracts contain a break clause covering a very limited period. Generally speaking, the opinion of experts is, that while there may be considerable disorganisation immediately after the cessation of hostilities, having regard to the large amount of arrears of work to be undertaken, the introduction of new industries, additional foreign trade, and a general development, there will be an enormous demand for steel of all descriptions, and consequently the present volume of trade may be expected to be not only maintained for some years, but very possibly exceeded. In all the main branches of the trade of the city there has been increased activity during the past week, and this is especially noticeable in the overseas department. While still far below normal, the tonnage of steel and steel products exported to the United States, the Colonies and neutral countries has been steadily increasing week by week. Large shipments of railway steel and stores have been made to South Africa and South America, India has become an increasingly active market, while heavy consignments of high-speed, electric and tool steel generally have been forwarded to the States. Local orders are for all descriptions of hand tools for army use, chiefly machinists and small tools, hand and circular saws, excavating and similar tools, vices and anvils. Tool-makers are booked ahead for many months to come.

South Yorkshire Coal Trade.—There is no change in the position of house coal, and generally the situation is becoming more and more acute. The output shows considerable increase in the summer months, but the pressure on collieries becomes greater than ever. The metropolitan area continues to demand full supplies, and the tonnage available for distribution to outside areas is distinctly limited, and far below ordinary requirements. In steam fuel the demands of the Admiralty and the Allies continue heavy and all classes are in active request, both for inland consumption and for shipment. Collieries are fully occupied on contract deliveries. Stocks for coke-making are difficult to obtain. The pressure for by-products and furnace coke is great and many plants are, with difficulty, able to maintain their operations. Quotations:—Best branch handpicked, 27*s.* to 28*s.*; Barnsley best Silkstone, 27*s.* to 27*s.* 6*d.*; Derbyshire best brights, 25*s.* to 26*s.*; Derbyshire house coal, 22*s.* 6*d.* to 23*s.* 6*d.*; best large nuts, 22*s.* 6*d.* to 23*s.* 6*d.*; small nuts, 21*s.* 6*d.* to 22*s.* 6*d.*; Yorkshire hards, 22*s.* 6*d.* to 23*s.* 6*d.*; Derbyshire hards, 21*s.* 9*d.* to 22*s.* 9*d.*; best slacks, 18*s.* to 19*s.*; seconds, 16*s.* to 18*s.*; smalls, 13*s.* to 14*s.*

Alcohol Motor Fuel Committee.—Mr. Walter Long has appointed a committee to investigate the available sources of supply of alcohol, with particular reference to its manufacture from materials other than those which can be used for food purposes, the method and cost of such manufacture, and the manner in which alcohol should be used for power purposes. Sir Boverton Redwood, Bart., Director of Technical Investigation in H.M. Petroleum Executive, is the chairman. Mr. Shrapnell-Smith will act as secretary to the committee, and all communications should be addressed to him at the office of H.M. Petroleum Executive, 12, Berkeley-street, W. 1.

Heat Balance of a Continuous Brick Kiln.—In the Transactions of the American Ceramic Society, 1917, pages 216 to 247, C. B. Harrop gives the results of a heat-balance test of a continuous tunnel kiln based upon observations taken during a six hours' run of the kiln. The kiln investigated is of the moving-car type and forms a tunnel 197 ft. long, 4½ ft. wide and 8 ft. high internally. On each side are two hand-fired furnaces; the gases pass from the grates first up vertical flues and then down again to the main flue which runs transversely underneath the kiln to a chimney. The kiln holds 36 cars, of which 17 are heating up, while 4 are in the high-temperature zone, and 15 are cooling. The detailed figures given by Harrop distinguish between the moisture of the clay, the moisture of the air introduced, the water produced by the combustion and the moisture evaporated from the ash pits, which are depressed and kept full of water; this latter item amounted to 1·79 per cent. of the total heat of the fuel. The other figures of the heat balance were, all in per cent. of the heat of the fuel supplied: 3·27 per cent. lost in unconsumed fuel; 2·5 per cent. in combustible gases; 23·3 per cent. leaving the kiln in the dry combustion gases and in the air excess; 17·07 per cent. leaving the kiln in the burnt ware and clay and in the car structure, 0·20 per cent. more in the iron of the car; and 45 per cent. losses of heat by radiation and convection. It is calculated that the excess of air in the flue gases was 352 per cent., and that 13·3 per cent. of the fuel might have been saved if this excess had been reduced to 100 per cent. A little over 200 per cent. of the air excess was supposed to have leaked into the kiln through the inlet end. The total fuel consumption was 11·15 per cent. of the weight of the goods burnt, or 725 lb. of fuel per thousand bricks. Such estimates are obviously very difficult, and a period of 6 hours is insufficient for reliable estimates; yet the figures indicate the possibility or at any rate the need of economies.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Trade.—Notwithstanding increased the Allies, and very heavy home demands. The position is being handled better and the iron available is being distributed as equitably as circumstances will allow. The position is relieved to no small extent by the Ministry of Shipping having placed more steamer tonnage at the disposal of traders. Supply of forge iron is very ample, and sales of fair quantities for delivery to the end of the year are reported. Wherever possible forge iron is being mixed with the better qualities and thus relieve the position as regards the latter. For home consumption, No. 3 Cleveland pig-iron, No. 4 foundry and No. 4 forge are all quoted 95*s.*, and No. 1 is 99*s.*; and for shipment to France and Italy, No. 3 and the lower qualities are 122*s.* 9*d.* and No. 1 is 127*s.* 9*d.*

Hematite Iron.—Little news is ascertainable concerning East Coast hematite. Output is by no means in excess of current requirements, but all urgent needs are being adequately dealt with, and a steady business is thus passing. Shipments are made to the Allies as tonnage becomes available, Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use and 147*s.* 6*d.* for export to France and Italy.

Manufactured Iron and Steel.—The various branches of the finished iron and steel trades are characterised by much firmness and great activity. Output is on an enormous scale, and pressure for delivery is unabated, demand for light sheets being especially pronounced. To home customers the following are among the principal market quotations:—Light sheets, 16*l.* 10*s.* to 18*l.* 10*s.*, according to gauge; common iron bars, 14*l.* 15*s.*; best bars, 15*l.* 15*s.*; double best bars, 16*l.* 15*s.*; triple best bars, 17*l.* 15*s.*; iron ship plates, 13*l.* 10*s.*; iron ship angles, 13*l.* 17*s.* 6*d.*; iron ship rivets, 21*l.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 12*l.* 10*s.*; steel strip, 17*l.* 10*s.*; steel hoops, 18*l.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.* Whilst export quotations are not fixed they may be given as approximately 40*s.* above home prices.

Coke.—Some local consumers are receiving better and more regular supplies, but deliveries cannot be depended upon, and in several cases continue from hand to mouth. Average blast-furnace coke is 33*s.* at the ovens, and low phosphorus quality is 35*s.* 6*d.* at the ovens. Good foundry coke is selling to neutrals at 65*s.* f.o.b. Middlesbrough Dock.

Motor Traffic Test Case.—The General Committee of the Commercial Motor Users' Association has decided to provide the necessary funds to carry to the House of Lords the test action for alleged extraordinary traffic damage to roads, raised by the Weston-super-Mare Urban District Council, against well-known quarry owners in the district, Messrs. Henry Butt and Co., Limited, members of the association. The claim in this test action was for 1,750*l.*, and Mr. Justice Eve gave judgment for only 250*l.*, but the importance of the issues at stake in relation to future developments of road transport constitute the one case which must be taken to the House of Lords for a final ruling. The points of interest on the issue are as follows: (1) Whether or no the change from horse to motor haulage for the conduct of the same traffic is to be admitted a ground for making an extraordinary traffic claim. (2) The correctness of the judgment by Mr. Justice Eve, having regard to the fact that the learned judge himself found that the whole of the operations were in connection with an industry well established in the neighbourhood, and carried out in precisely the same way as that adopted by other quarry owners in the district, and that the wagons were good ones and neither overdriven nor materially overloaded. The defence is in the hands of Mr. W. Joynson-Hicks, M.P.

British Trade with the Empire.—An important subject relating to the standardisation of the laws and procedure affecting British trade and the form of British products (such as machinery and engineering products) throughout the Empire was discussed at an interesting informal meeting recently held between the Prime Ministers of our Colonies, *i.e.*, Canada, Australia, New Zealand and Newfoundland, and certain representatives of the Federation of British Industries. One of the points dealt with was the desirability of establishing throughout the Empire a standard form of declaration which British manufacturers must make to secure the advantage of preferential cutoms rates. A model form of declaration has been drawn up by the Federation of British Industries and is being submitted to the High Commissioners of the various Dominions. Another important subject which met with a very friendly reception by the Overseas Prime Ministers was the question of uniformity of British laws and procedure throughout the Empire. A suggestion to the President of the Board of Trade has been made by the Federation on the ground that it would be to the interest of British manufacturers if the Bill which the Board of Trade is expecting to present to the House of patent law was held over and steps taken to summon a conference of representatives of different parts of the Empire with a view of putting the patent law and procedure of the Empire as far as possible on a uniform basis. A discussion also took place with regard to the standardisation of laws; regulations affecting the forms of British products disclosed many difficulties owing to the great diversity of legislation—Federal, State, municipal and otherwise. The Prime Ministers took a great personal interest in the whole of the above discussion and it is hoped that important results will follow.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—With the continued heavy demand for steel of all grades, the works are kept going at full pressure, shipbuilding material in particular being much in request. Steel-makers, however, have got this branch of their work well in hand now and deliveries are maintained with the utmost despatch. Flats and shapes for locomotive and construction shops are a big item, and so also is high-tensile steel for shell bars. The bulk of the steel manufactured at the moment, however, is that required for home use, although with better stocks available it almost seems as if the time were ripe for makers to launch out with some more export, especially as some of the material recently purchased by Government from America has now been stocked in Glasgow.

Malleable Iron Trade.—Malleable iron makers report such excellent business that without a high priority certificate it is impossible for any material to be delivered to a customer. War demands are pre-eminent, so much so that shipbuilding sections, rivet and bolt iron, concrete bars, and rolling stock sizes now take the place formerly devoted to agricultural parts and sections. Firm prices still rule.

Scotch Pig-Iron Trade.—The demand for pig-iron of all grades shows no sign of slacking-off, particularly as the rations distributed to consumers fall far short of the actual quantity required. In order to keep pace with the necessities of the shipyards, steelmakers in the West of Scotland are constantly clamouring for supplies of hematite, yet, even with the best system of production possible at the moment, smelters find great difficulty in meeting these many demands. No effort which will effect increased delivery is left untried. Naturally this means that the entire output is being used for home consumption, with little available for overseas' claims. Forge quality is much more plentiful than it was, but No. 1 foundry grade is correspondingly scarce. All over the activity is very pronounced, with prices firm and likely to remain so.

Shipbuilding on the Clyde.—Port Glasgow is very busy just now, and during the past ten days or so four large merchant vessels have been launched with an aggregate gross tonnage of nearly 30,000. Three of these ships were put out from the yard of Messrs. Russell and Co., while the fourth was the work of Messrs. W. Hamilton and Co.

TECHNICAL JOURNALS FOR THE OVERSEAS FORCES.—The distribution of technical motor and engineering papers to the A.S.C., M.T., Overseas, has been maintained since July, 1918. Parcels have been dispatched each week to the units in France, Egypt, Salonica and Mesopotamia—the addition of the last three bases during the past six months or so has more or less exhausted the very large stock of papers which those interested in the scheme from time to time forwarded. As possibly those persons who have kindly assisted in this scheme have further accumulated back numbers of technical journals dealing with the motor and engineering industries, these should be forwarded as soon as possible, so as to maintain in full the parcels we are continuing to send each week. No distinction is made as regards papers which are forwarded, and all technical papers dealing with the subjects stated are welcomed by the troops. Parcels should be sent, carriage paid, addressed to the Business Manager, *Motor Traction*, 20, Tudor-street, E.C. 4.

INSULATING RESISTANCES AT HIGH TEMPERATURES.—Measuring the electric resistance of some metallic oxides at high temperatures in a vacuum and in a nitrogen atmosphere, Emil Podszus noticed striking differences in the two series. The investigation is not completed; as Podszus had to join the army last year, however, he gave a preliminary account of his experiments in the *Verhandlungen der Deutsch. Physik. Gesellschaft* of October 30, 1917. The specimens were small compressed rods of the carefully purified oxides, about 1·3 mm. thick, 10 mm. long, and heated in a small electric furnace formed by a spiral of tungsten tape, 0·2 mm. thick, suspended in a glass globe, which was evacuated to 1 mm. or 2×10^{-4} mm. of mercury or filled with nitrogen at atmospheric pressure. The globe was previously heated to 400 deg. C.; for the measurements the spiral was heated up to 2,000 deg. C. by alternating currents. The oxides examined were CaO, MgO, Al_2O_3, ThU_2, and further boron nitride BN, the preparation of which by Podszus we noticed some time ago. In all the cases the resistance decreased greatly as the temperature was raised, in the case of calcium oxide from 1,330,000 ohms at 1,510 deg., to 80,000 ohms at 1,690 deg., and in most cases the resistance in nitrogen was much smaller (only about half) in the nitrogen atmosphere than in the vacuum. In the case of alumina there was very little difference in the two series, however, the resistance being 3,380,000 ohms at 1,550 deg. and 410,000 ohms at 1,775 deg.; we leave out the intermediate values. But the boron nitride showed much higher resistances in the nitrogen than in the vacuum, the figures being: 6,000,000 ohms at 1,620 deg., 1,300,000 ohms at 1,750 deg., 230,000 ohms at 1,930 deg. in nitrogen, and 700,000 ohms and 100,000 ohms at 1,680 deg. and 1,840 deg., respectively, in the vacuum. Dissociation of the compounds and thermoionic currents would affect the resistance in addition to temperature. From the behaviour of the substances mentioned and also of metals heated in a small tungsten cage, Podszus concludes that the thermoionic emission goes parallel with ordinary evaporation; further investigation is, however, required.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—The general situation in the South Wales coal markets has improved during the last day or two, but production continues to be dependent on day-to-day conditions. The Admiralty collieries, however, have been fully at work, and hardly any time has been lost at the better-class collieries, but other concerns have not fared so well. Strong representations are being made to the authorities to improvise such arrangements as will enable the collieries to meet the waggon difficulties arising from temporary circumstances.

Newport.—The outputs of Monmouthshire coals are better than they have been for many months past. Production generally is at its maximum at this period of the year. Best Black Vein pits are working well and shipping heavily. There is a good market, too, for the more bituminous Eastern Valley coals, but smalls are weak and even washed descriptions are still lacking strength.

UNEMPLOYMENT IN SWEDEN.—In spite of very serious difficulties in the matter of raw materials, there has been comparatively little unemployment in Sweden during the war, but prospects at present are less reassuring. Thus a large amount of unemployment is apprehended in the sulphate and the paper industries, owing to the reduced exports to Germany, and many works will either have to close up or reduce their output. The saw mills industry in North Sweden is also in a difficult position, many mills having greatly reduced their production.

PERSONAL.—Professor W. A. Bone, F.R.S., with the concurrence of the authorities of the Imperial College of Science and Technology, has asked to be relieved of his duties as Consultant to the Fuel Research Board, on October 22nd next, in order to be free during the coming winter to devote his attention to plans now under consideration for the post-war development of the Department of Chemical Technology at the college. At the same time he will resume his private consulting and his other work in fuel technology which has been suspended during his tenure of the office.—Mr. Arthur Hoare has resigned his position as Buying Engineer to the Ministry of Food, in order to rejoin the management of John Birch and Co., Limited, of 2, London Wall buildings, E.C.—The General Electric Company, Limited, inform us that they have completed the purchase of the Erith Works, and of the goodwill of the manufacturing business hitherto carried on by Messrs. Fraser and Chalmers, Limited. Practically the whole of the personnel have transferred their services to the General Electric Company, who will carry on the business as a going concern and under the title of Fraser and Chalmers Engineering Works.

TEMPERATURE UNIFORMITY IN ELECTRIC FURNACES.—In order to maintain a region of uniform temperature in an electric furnace, full compensation has to be made for the heat losses at all points within this region, and as the heat losses are not uniformly distributed within a furnace built up of different parts, the heat supply must likewise be non-uniformly distributed. The ends of tubular furnaces are hence specially heated by crowded (more closely wound) coils and the different coils are joined to two or even to three different circuits. When the ends or certain lengths of the tube can partly be closed by plugs, the plugs should be good conductors on the inside, in order to secure uniformity of the temperature in the vertical section, and good heat insulators on the outside. Discussing these problems and the various means adopted for solving them in the *Physical Review* of July last, J. B. Ferguson, of the Geophysical Laboratory, Carnegie Institution, Washington, describes a tubular furnace, 45 cm. in length, in which he can maintain a temperature constant within 0·25 deg. C. for more than an hour at temperatures of 1,000 deg. or 1,200 deg. C. and constant within $\pm$ 0·5 deg. C. for the range lying between 620 deg. and 1,190 deg. C. The central zone of uniformity has a length of 10 cm. or 12 cm. and a diameter of 6 cm. The essential parts of the furnace are two concentric alundum tubes, coils belonging to three different circuits, plugs, and external insulating packing of magnesia (inside), fireclay, calorox (outside). The furnace is provided with an outside shell of sheet iron painted with aluminium. The coil arrangement is peculiar. The two ends of the inner alundum tube are first wound with platinum wire over lengths of 10 cm.; the wire is covered with alundum cement and baked, and the inner tube is then slipped into the outer tube, into which it just fits after grinding off the excess of insulation. The inner ends of the coils mentioned are passed through holes in the outer tube, and wound back on the outer tube to its ends. The central portion of the outer tube is then uniformly wound with platinum wire; the end windings already spoken of may be uniform or crowded. The peculiar winding is recommended because, it is said, alundum is not so good an electric insulator as is often assumed; all the coils are covered with alundum cement, but some furnaces did not even survive their trials. Ring discs of alundum are fixed by means of water glass to the outer ends of the furnace tubes. The cylindrical plugs are filled with calcined magnesia. Temperatures are determined by means of thermo-couples of platinum/platinum-rhodium, and use is made of a compound couple which admits of taking direct or differential measurements at any one of three points with four leads only. For this purpose separate platinum wires are soldered to three points of the same alloy wire (Pt. Rh.).

NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, October 18, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster. Papers: "A Law Governing the Resistance to Penetration of Metals which are Capable of Plastic Deformation, and a New Hardness Scale in Fundamental Units," by Professor C. A. Edwards and Mr. F. W. Willis, of Manchester; "The Value of the Indentation Method in the Determination of Hardness," by Mr. R. G. C. Batson, of Teddington, Associate Member; and "The Ludwik Hardness Test," by Dr. W. Cawthorne Unwin, F.R.S., of London, Past-President.

THE STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Saturday, October 19, at the Institute, Wolverhampton-street, Dudley, when Mr. George Carrington will give his Presidential Address. Chair to be taken at 6.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Saturday, October 19, the first lecture of Session 1918–19 will be given as an inter-lecture with the Textile Society, in the Kiosk Cafe, North-street, Keighley, by Mr. Thomas Carter, of Newcastle. Subject: "Some Working Principles of Electrical Machinery." Chair to be taken at 7 p.m. by the president of the Textile Society (Mr. F. N. Binns).

NORTH-EAST COAST INSTITUTION GOLD MEDAL.—The Engineering Gold Medal of the North-East Coast Institution of Engineers and Shipbuilders has been awarded to Mr. Harry R. Ricardo, B.A., for his paper, entitled "High-Speed Internal-Combustion Engines," which was read before the Institution on April 30 last.

CONTROL OF COKE.—From Monday last, the price of gas coke for household and industrial purposes is controlled throughout England, Wales and Scotland by a new Order of the Board of Trade. Hitherto, in the Metropolitan Area, there was an agreed price with the gas companies, and in other parts of the country, although recognised prices prevailed, there was nothing to prevent gas companies or any other dealer charging higher prices. The effect of the Order is that the price of gas coke shall not exceed in any district the price of the second list of house coal. Industries which use gas coke to the extent of 50 tons per month on a yearly contract will obtain a discount of 10 per cent. The maximum price of unscreened coke breeze will be 60 per cent. cheaper than that of ordinary large coke. Industrial users of over 600 tons a year will again have a 10 per cent. discount. The prices of second list coal, on which the prices of coke are based, are fixed by the Local Coal Committees in each district.

THE GAS INDUSTRY AND PUBLIC SERVICE.—At the seventh annual general meeting of the British Commercial Gas Association held at the Royal Society of Arts, John-street, Adelphi, W.C. 2, on Wednesday afternoon, October 16, the president, Sir Hallewell Rogers, J.P., in introducing the incoming president, Lord Moulton, P.C., K.C.B., F.R.S., Director-General of Explosives Supplies, said that apart from its prompt action in meeting the need for explosives in the early days of the war and in releasing men for the fighting forces and experts for the laboratories, the gas industry had done invaluable work for the country in the quick improvisation of depots, canteens, hospitals and other establishments for the militant army, and of factories and workshops for the industrial army. It had set itself to providing fuel oil for the Navy; had furnished the farmer with cheap and indispensable fertilisers; had been an important source of ammonia supply; and, last but not least, had furnished enormous supplies of gaseous fuel to munitions works of all kinds, as well as in increasing quantities to all branches of industry and to the homes of the people.

PEACE PLANS OF THE AUSTRIAN WAR INDUSTRIES.—Some information has already transpired as to the manner in which the Austrian war industries intend to employ their increased plant and capacity after the war. The machine industry will go in for several new branches, typewriters, motor ploughs, motor cars, electro-technical articles, &c. The motor-car industry will be taken up by the Austrian Arms Factory, which company has built large works at Steyr, by the Skoda Works, and others. Austria has formerly imported large quantities of motor cars from abroad, in the year 1913 for about 15,000,000 kronen, the greater part coming from France, Italy, America, and more especially from Germany. The aeroplane factories in Austria have also taken up the manufacture of their own motors. Typewriters have hitherto been manufactured by two small Austrian factories, mostly for the Balkans, but Austria's own consumption was almost exclusively covered by imports; considerable quantities hailed from America and England, but about half the imports, representing a value of 7,000,000 kronen, came from Germany in the year 1913. The manufacture of motor ploughs will be taken up in Austria by a number of firms, some of which are already manufacturers of agricultural machinery. The imports of motor ploughs into Austria during the last year before the war were valued at about 6,000,000 kronen; of these, Germany supplied more than the half, whilst England's share was less than the half, or 2,400,000 kronen in value: America's share was insignificant. The Austrian industries are sanguine of being able to manufacture a substantial proportion of the country's needs in electrical machinery, which before the war, came mainly from Germany

APPRENTICE CLUB.

SCOTTS' SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, GREENOCK.

(*For Description, see Page* 440.)

FIG. 1. READING ROOM AND LIBRARY.

FIG. 2. A CORNER OF THE STUDY.

FIG. 3. RECREATION ROOM.

FIG. 4. GYMNASIUM.

ELECTRIC TRACTION ON THE CENTRAL ARGENTIN AILW

MESSRS. MERZ AND McLELLAN AND MESSRS. L SON, A

(For Descri Page 427

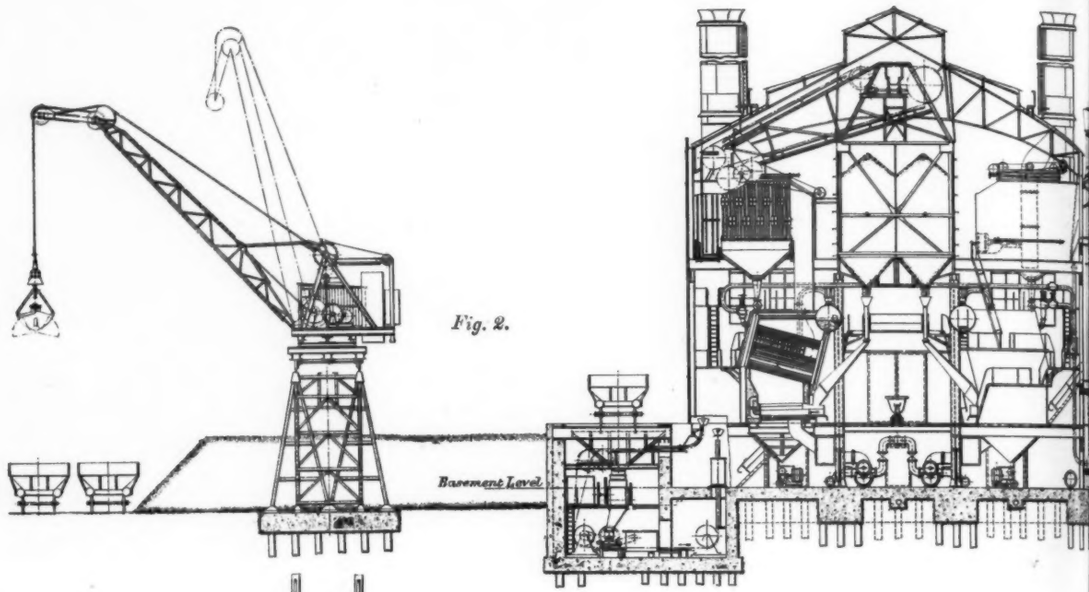


Fig. 2.

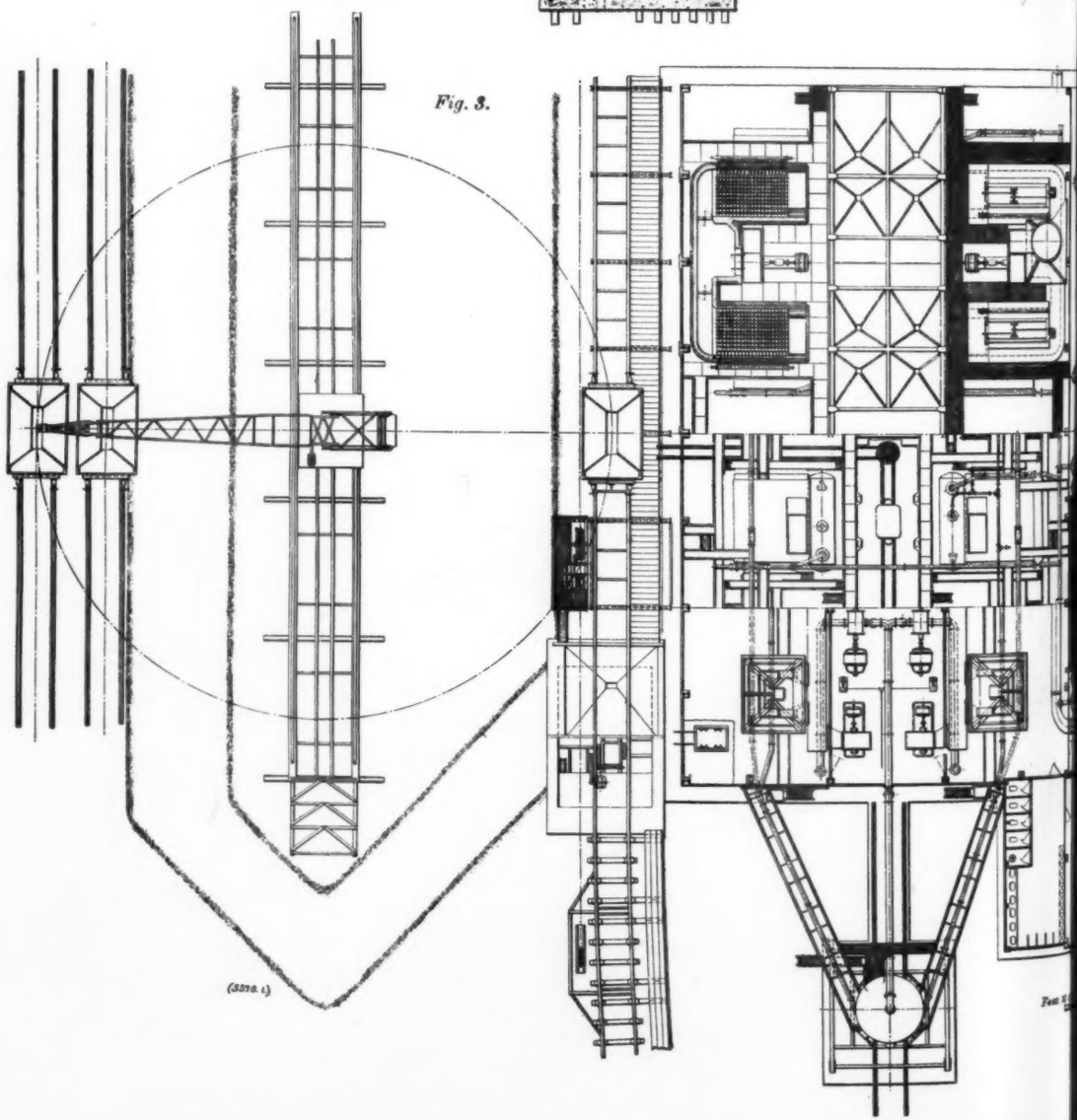
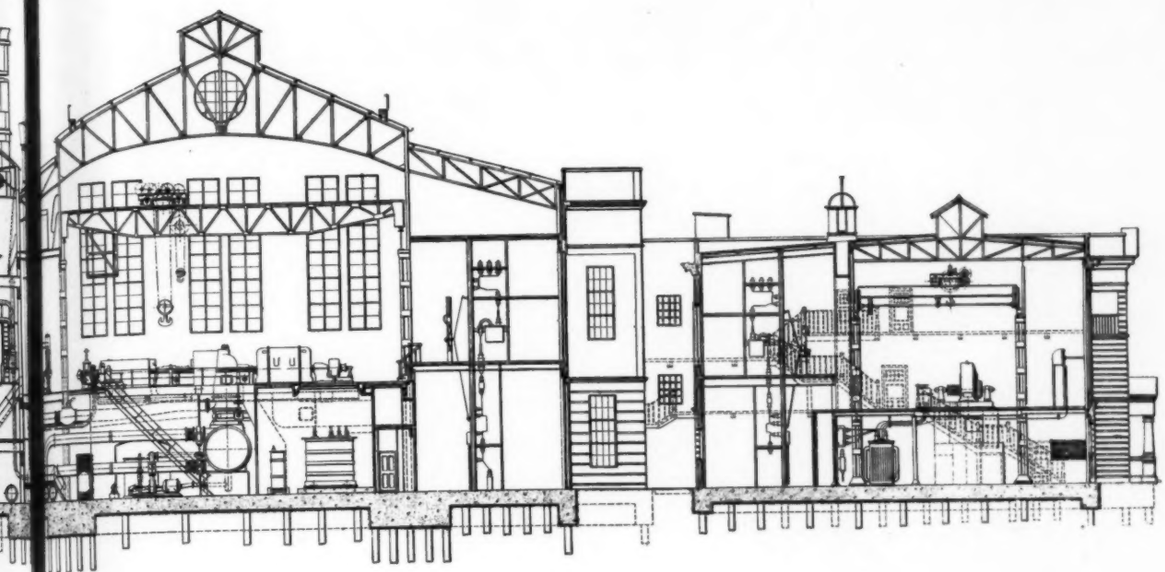


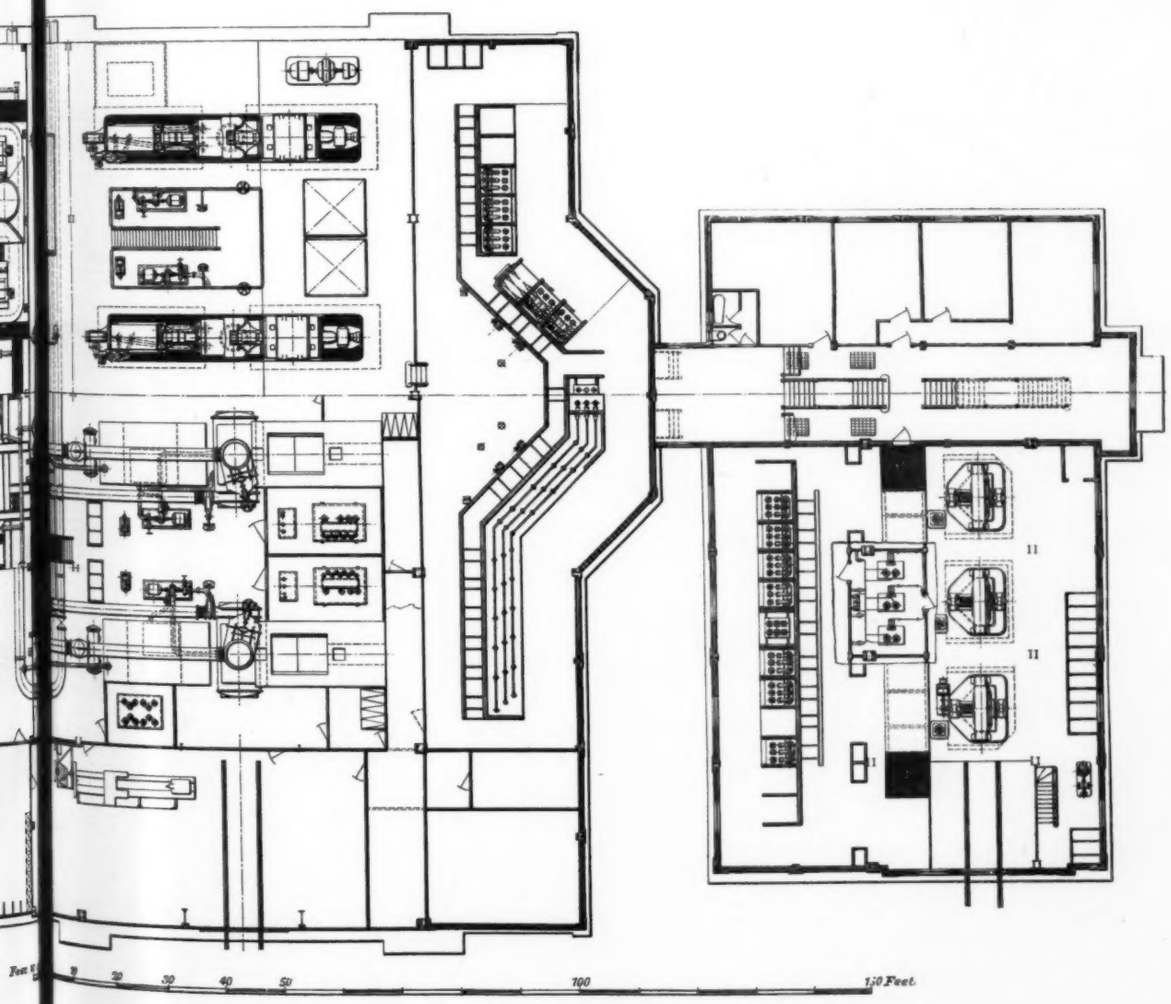
Fig. 3.

AILWAY; POWER-HOUSE AT CANAL SAN FERNANDO.

SON, AND HENDERSON, ENGINEERS, LONDON.

(Page 427.)





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TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—8668 and 8596 GERRARD.

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With a Two-Page Plate of the ELECTRIC TRACTION ON THE CENTRAL ARGENTINE RAILWAY: POWER-HOUSE AT CANAL SAN FERNANDO.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal further from 8d. to 9d. per copy. This increase dates from and includes the issue of Friday, March 1, 1918. The change will not apply to unexpired subscriptions. The revised rates for new subscriptions are given in the adjoining column.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents will not have copies for chance customers; therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 435.

ENGINEERING.

FRIDAY, OCTOBER 18, 1918.

INDUSTRIAL RECONSTRUCTION.

FOR a long period anterior to the war the industrial situation in this country had been in a far from satisfactory condition. The unrest does not seem to have been due in the main to purely economical questions. Indeed, an American observer, writing on the situation as it appeared to him, had remarked on the curious feature that, as he expressed it, "money ceased to pull," men being unprepared to give a greater output for a greater return. Indeed, in many cases it would seem that they were more eager to injure their employers rather than to improve their own conditions. That the unrest has been by no means most marked in the poorly paid trades is of course a commonplace. It is possible that the high wages taken during recent months may have created fresh wants and that consequently money will again prove an effective incentive to production. Should this be the case the problem will be materially simplified. Unfortunately there is still evidence that this short-sighted desire to cut down profits, whatever the ultimate cost to themselves and the community, still persists amongst many workmen. A few months since, for example, a London firm succeeded, after a long series of experiments, in manufacturing on a turret lathe a machine component which had hitherto been made on a precision lathe. The immediate result was that many of the workmen immediately reduced their output of certain other components, with the intention of maintaining the total labour costs unaltered, and preventing thereby the firm making any profit from their ingenuity. If this spirit is to be maintained the outlook is, indeed, hopeless, and it is therefore highly important that the more reasonable men on both sides should get together and endeavour to establish a *modus vivendi*. Several associations have been formed with this object. Amongst the most active is the National Alliance of Employers and Employed, of which Mr. J. Huth Jackson is chairman. Included amongst the members are such strenuous advocates of the claims of labour as Mr. W. A. Appleton and Mr. J. Havelock Wilson.

This body aims at settling labour difficulties before the state of tension is such as to make a strike inevitable. The Government Departments which have dealt with these matters during the past four years have doubtless meant well, but have seldom intervened until matters have already come to a crisis. What is wanted is some body that shall anticipate events, and mitigate a grievance before it assumes serious proportions. To this end the National Alliance proposes that a central industrial Board shall be constituted, consisting of representatives of employers' associations and trade unions in equal numbers and of the Government Departments concerned. This Central Board is to deal with the problems of demobilisation, the absorption of displaced female labour, national minimum wage questions, housing, technical education and welfare work. A certain devolution of these functions is to be made to area boards conversant with local conditions and constituted on similar lines to the central board, with representatives of the local authorities taking the place of the Government officials on the central board. In addition, there will be, it is suggested, National and District Industrial Councils, constituted of representatives of employers and the trade unions in equal numbers. These would deal with all questions relating to wages.

A Wages Appeal Tribunal is proposed, the members of which would be drawn from two panels appointed respectively by the employers and by the trade unions, who acting in conjunction would appoint a third panel of independent chairmen. The tribunal would consist of one member drawn from each panel and would deal with matters of wage adjustment only when the National Council concerned had failed to effect an agreement.

Matters are perhaps more promising for the success of such a scheme as this now, than would have been the case four years ago. Both sides have learnt much. The trenches have given each a mutual respect for the manhood of the other, and the Bolshevist fiasco must have a constantly increasing effect in bringing home to the industrial classes generally the fallacy of the economic theories on which they were fed for years before the war. It is not many years since that one well-known Labour leader declared that the working classes could do for themselves all those things by which money made money. Probably he would not repeat this now after the Russian fiasco. Moreover, as was pointed out in the parable of the talents nearly twenty centuries ago, money does not make money. The talent wrapped up in the napkin remained merely a talent still. Money and labour are in short the tools used by mind, and the quality of the controlling mind determines whether the employment of these instruments shall result in an increase or in a diminution of wealth. No committee could replace an Andrew Carnegie any more than they could a Shakespeare. That Mr. Carnegie should make a large fortune was a necessary concomitant to the rapid development of the American steel industry. Had his profits been limited during the process, as has been suggested by certain writers, whose fluency is only paralleled by their lack of insight, the development of the American steel industry would have been retarded for decades, and the Hun might now dominate the world. Mr. Carnegie's gain, large as it was, remained nevertheless a mere fraction of the gain to the "common people" of the United States, each of whom lives more easily because the intensified production of steel and iron has so cheapened transport, as to enable him to draw supplies from truly astonishing distances. Similarly the large profits made in our shipping trades, were ploughed back into the business, and gave us the unparalleled merchant fleet which even in war conditions has carried meat to us for 10,000 miles at an inclusive cost for loading, conveying, refrigeration and discharging of under 1d. per lb. No one who fairly faces the problem will be able to persuade himself that such a result could have obtained in any other way.

Whilst the industrial classes must recognise the necessity that the able employer shall reap large profits if we are to improve our pre-war standard of living, the employer must on his part cease to grudge the able working man his fair reward. Every one knows of cases in which if a workman by special ingenuity or skill, succeeds in, say, doubling his earnings, he is penalised by a heavy cut in piece prices. Such an appropriation of ideas without recompense is hardly distinguishable from simple theft. On the other hand members of the Amalgamated Society of Engineers whilst protesting that they have no objection to the introduction of improved machinery and methods, not infrequently add that the price paid per piece must remain as before. It is but just that when improved machinery is installed prices should be adjusted, but whether just or no it is certainly impolitic that the workman immediately concerned should not have some direct share in the gain. Matters of this kind may well be

adjudicated on by the boards which the National Alliance proposes to establish. Unreasonableness on both sides leads to tension in which mutual consideration is at a discount and an accumulation of pin pricks, no one of which in itself is sufficient to start a quarrel, may in the aggregate establish such a state of tension that but little more may develop a crisis.

Much to improve shop conditions may be done along the lines inaugurated by the late Mr. Taylor. A sense of injustice is the most potent cause of quarrels, and the Taylor system reduces the possibility of this feeling by determining with precision the actual facts. It is not at all evident why the workmen resent the plan of time and motion studies, but that they do is undoubted. The Taylor idea is not to drive men to exertions beyond their strength, in fact Mr. Taylor was the first to emphasise the necessity for periods of rest if industrial fatigue was to be avoided and output maintained. His plan was to increase production by discovering and removing obstacles to output, and providing means by which the workmen's task was made as easy as conditions allowed. Possibly the opposition to such studies may be due to the fear that unprogressive firms may attempt to secure Taylor outputs not by improvements in methods and equipments, but by sheer drive. This would certainly seem to have been the cause of the refusal of the glass workers Union for so many years to allow the regenerative glass furnace to be used in British factories. Of course, they were unable to prevent the furnace being employed abroad, and in fact only removed their ban when trade had been largely lost to these countries. Similarly, a refusal of the workmen here to accept Taylorism will not kill the system, but merely transfer trade to more enlightened communities.

Nevertheless much has been learnt during the past four years, and the "ca canny" policy has inevitably lost ground. We are still however far from the industrial Utopia in which so far from obstructing the introduction of improved methods and plant, trades union will notify non-progressive firms that they must mend their methods and equipment or their labour will be withdrawn.

THE POSITION OF WOMEN IN ENGINEERING.

A new departure was made at the annual conference of the National Council of Women of Great Britain and Ireland, held at Harrogate from October 8 to 11, by including in its programme a public meeting to hear papers read on the Position of Women in Engineering. Great interest was taken by the delegates, and the public in this meeting—and it was evident that the subject of engineering for women is arousing very intelligent interest and a great desire for further information.

Mr. Ben Morgan, of the Ministry of Munitions, gave a description of the work women had been doing with success for some considerable time past in munition shops and in general engineering works. Besides the usual operations of turning, boring, screwing, milling, and other machinery operations, they were, he showed, engaged to a great extent on gauging and viewing, and were very skilful at marking off. He considered that generally speaking women excel in machining work rather than in fitting work, that while they do not easily tire of machining operations with constant repetition work, they tire much more easily on repetition fitting work. Women are specially suitable for such semi-skilled operations as tracing and draughting, and marking off the lighter work of many kinds, and they acquired great skill on subdivisions of accurate tool-room work. Mr. Morgan spoke of the various arrangements with the men's unions and explained to the audience the meaning of skilled work according to the Amalgamated Society of Engineers' definition. He concluded by recommending women not to hibernate in their homes as they had done before the war, but to come out into the open and make a good fight to keep the new ground they had won.

Miss Rachel Parsons gave some instances of the less known types of munition work now being done by women, showing that many of them take a great interest in the subject from a scientific point of view. Girls are grinding the lenses for telescopes and testing them, work which requires great care and some months of training. Another interesting type of work is the backing of the mirrors for searchlights. The mirrors are, except in the large sizes, backed by lead and wire gauze held in place by a metal band, and all this work is done by girls.

Turning next to work being done by university women, Miss Parsons stated that they are carrying out researches on optical glass, and some of the work involves a great deal of mathematical calculation. Some of the experimental work on models of ships in the tanks is done by a woman. One girl, before the war a school teacher, is carrying out electrical tests on armatures. In the drawing office girls are a fairly recent innovation. One girl is doing some of the graphical calculations in a turbine design office; for instance, she has drawn the deflection diagram for a propeller shaft; others are doing some of the calculating work for the same office involving use of slide rule and mathematical tables. The work has been split up in much the same way as it is often done in engineering shops so that the girls can do the simpler part while the experienced designers can devote their time to the more important work. Several women were present at the meetings of the Institute of Metals and the Iron and Steel Institute, although the papers are decidedly technical. The paper ended by touching on the question of pay and the women's organisations, and stated that with the end so nearly in sight it was vital that no strikers should mar the victory gained.

Dr. Rhoda Adamson, of Leeds, explained the great care taken by the firms for whom she works in grading the women according to their physical strength and health. In her opinion a naturally strong muscular woman can do nearly as much heavy work as the average man. But the women require much more careful grading than men. Miss F. Campbell and Miss Amy Dickinson also described the work they were doing for their respective firms.

At a subsequent session, the Hon. Lady Parsons spoke to a resolution that had been forwarded by the branches at Glasgow, Newcastle, Leeds, York, Hull and London, asking for the inclusion of skilled technical women to sit on all reconstruction committees dealing with engineering industries. Lady Parsons said it would be a great advantage if some skilled technical women, who could do the work themselves, and understand the conditions, could be included on all committees dealing with reconstruction. The rule the Amalgamated Society of Engineers brought in that women must receive the same pay as a man directly she began to work on a skilled job, however inexperienced she might be, had been a great setback to the progress of women in general engineering shops. Women were no longer allowed to learn the work at a lower rate of pay, and no employer could afford to employ women on skilled work with no previous training. Although later on some modifications were made and the rule was in a measure got over by the subdivision of jobs; the check had been made, women were discouraged, employers and foremen thought it less trouble to employ boys, and the women had gradually been taken out of the more skilled jobs. Lady Parsons considered that if some practical, technical women had been helping with the negotiations, a more favourable bargain might have been made with the Amalgamated Society of Engineers. Mrs. Wilson, M.B.E., Halifax, said women would have to leave the shops after the war—in many cases the firms would suffer. She thought the promises should not be blindly adhered to, until a committee, composed of men and women, had investigated the matter.

The resolution proposed, as eventually amended, ran: "In view of the large numbers of women earning their living in engineering works, who are doing invaluable service to their country, and recognising that women are employed in almost every operation in engineering, the National Council respectfully urges on the Ministry of Reconstruction the immediate appointment of women with a practical knowledge of engineering to sit on all Reconstruction Committees dealing with engineering industries."

PETROLEUM IN ENGLAND: THE GEOLOGY OF THE PERSIAN OIL FIELDS.

In opening the new session of the Institution of Petroleum Technologists, at 5.30 p.m. last Tuesday afternoon, the President of the Institution, Mr. Charles Greenway, briefly referred to the inauguration by the Marquess of Hartington of the first boring for crude oil in this country, which had taken place on that same afternoon at Hardstoft, near Chesterfield, on the fringe of the Derbyshire coalfields. Plant, largely from America, has been laid down for ten wells which, if necessary, will be pushed down to depths of 4,000 ft.: it is hoped, however, that oil may be met with at depths not much exceeding 2,000 ft., and that six months' operation will give distinct indication of success. Forty American drillers are at present at work. The occasion had attracted many geologists and petroleum industrials and kept some of them away from the meeting we are about to notice. Addressing the assembly at Hardstoft, Lord Cowdray mentioned that the value of the imports into this country of petroleum during last year had exceeded 36,000,000*l*. The drilling, which was really the work of the Government, might be called "wild-catting" in America; but it was more than justified by modern knowledge. The average petroleum production of all the wells of the world might be estimated at 5 tons per well per day; some of the most prolific wells gave 7,000 tons per day. But the whole oil production represented only 5 per cent. of the world's coal production, and yet the experts of the Bureau of Mines were afraid that the petroleum wells of the United States would not hold out for more than another thirty years. It was for these considerations, which certainly are sufficiently weighty, that Lord Cowdray, before giving to the country the results of his discoveries, insisted that the Government should enforce care in drilling and should limit the number of wells to be sunk. The Petroleum Bill did not affect the ownership of the oil, and if it restricted the landowner, it also protected him from the risk that his neighbour might drill and thus steal his oil. Lord Hartington, speaking after Lord Cowdray, added that the well was sunk by the Government with the consent of the Duke of Devonshire, the landowner; when the time for settlement would have come, after the war, they were not prepared to see large fortunes made out of Derbyshire oil without compensation to the landowner or occupier. Meanwhile the country depends upon oil supplies from other sources, and last Tuesday's discussion by the Institution of Petroleum Technologists concerned one of the sources which has become very important in recent years.

The paper, which Messrs. H. G. Busk, B.A., F.G.S., and H. T. Mayo, B.A., F.G.S., presented to the Institution, dealt only with the geology of the Persian Oil Fields. Only small portions of the vast concessions of the Anglo-Persian Oil Company have so far been surveyed, but much good work has been done, and considering the political difficulties and that the various actual or prospective Persian oilfields are hundreds of miles apart, and that some of the barren districts are forsaken by the native population during the hot season, geologists cannot be charged with having neglected their duty. Messrs. Busk and Mayo belong to the geological staff of the company, which consists of six geologists. The three regions they dealt with in their paper are (1) the Bakhtiari country, which is situated in the Persian province of Khuzistan, between the provinces of Luristan in the north, and Farsistan in the south, the latter on the Persian Gulf; (2) the Ahwaz and Pusht-i-Kuh country, more to the north-west and nearer the Turkish frontier; (3) the Qishm Island and the Persian Gulf region; this island is situated in the Gulf of Hormuz which connects the Gulf with the Indian Ocean, and the Persian provinces on the eastern, Persian side of the Gulf and further north are, from south to north, Laristan, Farsistan, Khuzistan and Luristan. The names re-occur in the names chosen for the designation of the geological strata which owing to the scarcity of the characteristic fossils and other facts, have not yet been sufficiently co-ordinated with other strata.

The country of the Bakhtiari Khans, who are

powerful chiefs and friendly to the British, though the people are extremely unfriendly to Europeans generally, is very rough, and the mountain ridges to the north-east, bounding the high plateau of Persia, reach to heights of 12,000 ft. The petroliferous region lies in the precipitous foothills which themselves attain heights of 4,000 ft.; the Maidan-i-Naftun oil field, from which the company's main production is now derived, is about central in the region and 17 miles from the Arabistan plains, across two foothill ranges, which the pipe lines cross at elevations of 2,000 and 1,600 ft. The pioneer geological work in the district was done by W. H. Loftus in 1849; in 1904 E. Pilgrim, later E. M. Cunningham Craig, G. B. Reynolds, B. Macrorie, S. Lister James and others further studied the geology, and of some portions of the fields one inch maps exist; but very much remains to be done, of course, in this district as in the others. The geology presents some rare if not unique features. The chief formations, proceeding from younger to older strata, are the Bakhtiari series (Pliocene), up to 15,000 ft. in thickness; the Fars series (Miocene, 7,200 ft.); and the Asmari series (2,000 ft.). The middle group of the Fars series is distinguished as a passage, and Mr. Busk, in mapping, makes use of symbols such as u^{10} to indicate that the respective horizon lies 1,000 ft. (10 times 100 ft.) above u^0, the base of the upper Fars, and p^{-8} that the horizon is (8 times 100 ft.) below the base p^0 of the passage. The main oil zones occur in the detrital limestone of the lower Fars, up to 3,500 ft. thick; the wells flow under strong pressure and show no signs yet of exhaustion after 10 years of phenomenal production; natural oil seepages are also prolific. The middle Fars likewise gives oil from the Naft-i-Safid, or white-oil-springs, and at Dareh-i Ail (Valley of Pitch). The peculiarity of the lower Bakhtiari series is that it seems to have been deposited in its locally enormous thickness during a long period of constant, but very gradual earth movement, for which Mr. Bush proposes the term "continuous unconformity." The oil fields, he suggested, were the result of a subsequent post-Pliocene movement, tangentially to the crust, which was very heterogeneous and might consist of any of the formations mentioned, so that the oil accumulation was determined largely by topographical accidents. The petroliferous group itself consisted in the main of embedded gypsum, with intercalated detrital limestone, the latter forming the reservoir rock. This gypsum became quasi-fluid under relatively light pressure, in land slides it behaved very similarly to glacier ice, and might show longitudinal and transversal crevasses and ice-falls. Another peculiarity of the close of the Bakhtiari period, during which the present-day drainage system was developed, and the Karun river worked its way through the mountains in a canyon now 800 ft. deep in some parts, was the folding of the exposed gypsum beds in fan-fashion or "omega structure," as they had called it in Persia. Oil was to be looked for in ground remote from the major thrust-faults.

The geology and oil prospects of the Ahwaz area, which Mr. Mayo has studied more in particular, were first investigated in 1913. Ahwaz is on the Karun river, which joins the Shat-el-Arab (the river to which the Euphrates and Tigris unite) at Mohammerah; it lies in a fold of low hills, striking about east-south-east to west-north-west—the apparent direction of most of the chains of Western Persia and also the direction of the Caucasus and the Western Himalaya. The fold has been traced for a distance of over 100 miles. The country is barren and water is wanting. The modern town of Shuster and the ruins of Susa lie to the north of Ahwaz. Forty miles of desert intervene between Ahwaz and the Tulkhayat white-oil springs to the north-east; to the south-west the great Mesopotamian alluvial plains stretch over to Arabia. The main geological formations are similar to those in the Bakhtiari country; in the neighbourhood of Ahwaz the undulations of the anti-clinal crest have led to the formation of elongated domes, partly salt domes; on the flank of one of these domes the first test well was drilled. There are no productive wells so far in this district, but the geological aspect is considered highly favourable. Interest in the geology of Qishm Island dates from the visit of the Admiralty Commission to the Persian Gulf in 1913–14; Messrs. James and Dewhurst, of the Burmah Oil Company, started the survey. Qishm is the largest island in the Persian Gulf, 60 miles long, nearly 10 miles wide. There are, again, salt domes in Qishm; they also occur in Transylvania, in Egypt, and particularly in the land north and north-west of the Gulf of Mexico, an occurrence which we recently noticed.* As to their origin there is much controversy; they may be examples of salt-plug action, a self-extrusion of underlying salt masses, or salt may have accumulated in the domes as a consequence of the initiation of dome structure. Messrs. Busk and Mayo discussed these and other theories of Cunningham Craig, Hume, James and Halse, Sir Thomas Holland and others. But we cannot attempt to abstract the geological detail of the paper, which embodies a great deal of excellent work, nor the discussion by Messrs. Lister James, C. V. Illing and others. We must content ourselves with indicating the character of the communication, which was illustrated by many maps—perhaps not all to be published at present. As to the production of the Persian oilfields and other matters, reference was made to last year's report presented to the shareholders of the Anglo-Persian Oil Company. Oil seepages have been recorded at many localities on Qishm Island, and at Bunder Abbas and at other points of the Persian coast. The prospects of the Bahrein Islands, situated in a bay of the Arabian side of the Gulf, are also considered favourable. On the whole, however, the Persian Gulf does not appear to offer the promises of the Bakhtiari district.

* See ENGINEERING, September 27, page 348, *ante*.

NEW BRITISH AND KEY INDUSTRIES EXHIBITION.

THE Exhibition at the Central Hall, Westminster, to which we referred in last week's issue, is now practically complete. Next to the metallurgical and engineering exhibits, which we have already noticed, coal and coal-tar dyes, graphite and further chemical products and chemical ware chiefly claim attention. As important materials for the chemical engineer and chemist, we first mention the tantiron of the Lennox Foundry Company which we described in our issue of August 9 last; the exhibits illustrate the manufacture of plant for the production of acids and of many chemicals (in which tantiron replaces platinum, china and earthenware, as well as iron) and of other products not made in this country before the war. The nickel laboratory ware and the nickel alloys of Messrs. Henry Wiggins and Co., of Birmingham, briefly alluded to in our articles on the King's College Exhibition, are also of considerable interest. There are crucibles, basins, dishes, spatulae, &c., of pure nickel, and vessels, metal sheets, wire, tape, solid drawn tubes, &c., both of pure nickel and its alloys; the wires and tapes of nickel, nickel silver and other alloys, are for electric resistances; prominent by the side of the metal sheets are, further, the compound metals, copper-nickel-brass, copper-steel-copper, copper-brass, brass-steel-brass; the mode of their preparation is not explained. The firm also supplies nickel oxides, which are valuable as catalysts. Nickel mirrors are exhibited by Mr. A. L. Hunt, of the Whippet Works, Clapham Junction.

In chemical glass ware there is little that we have not noticed in connection with the British Scientific Products Exhibition. As regards refractory furnace materials, the Leeds Fireclay Company has come forward this time; their big gas retorts, coke-oven blocks, firebricks and firebricks block, and blast-furnace lumps make an impressive show. A model gas retort is also exhibited by Messrs. Mobberley and Perry, of Stourbridge. Of other firms we may mention Messrs. C. E. Ramsden and Co., of Stoke-on-Trent, with respect to their chemicals and colours (various metallic oxides) for enamellers, potters, glass-makers, and Messrs. Keeling and Walker, of 35, Surrey-street, Strand, for the same products and paints; the Pilkington Tile and Pottery Company, of Clifton Junction, Manchester, are also represented. The Plaisetty Manufacturing Company, of Leyton (monazite and other rare earths, mantles, &c.) is connected with the London Thorium Company.

Models of coke ovens are exhibited by Messrs. Simon-Carves, of Manchester (one model), and by the Coppée Company, Ltd., of King's House, Kingsway. The Coppée company undertake the whole of the work connected with an up-to-date coking plant, comprising washery, coke ovens and by-product recovery plant of their own design and construction. Among their recent installations are those for the United National Collieries at Risca, Monmouthshire, for Messrs. Lancaster's Steam Coal Collieries, at Cwmtillery, South Wales, and for the Hardwick Colliery Company at Holmwood; in the Holmwood plant provision is made for the benzol recovery. The two large-size models exhibited represent a waste heat coke oven and a regenerative coke oven, and they embody the essential apparatus and accessories; the large coloured drawings displayed as well as the samples of by-products explain the operation of complete plants for tar distillation, the recovery of ammonia by the ordinary wet process and by the "direct" process, and for the recovery and rectification of benzol. In the direct process, to which the recent reports of the Alkali Inspector have paid considerable attention, the gas and vapours leaving the coke ovens are cooled in the ordinary way to about 90 deg. F. and are then passed through Pelouze exhausters for removing the tar; in the extractive perforated steel discs, several feet in diameter, mounted about ½ in. apart, revolve alternately in opposite directions. The ammonia in the vapour is then at once absorbed by sulphuric acid, and the ammonium sulphate is finally ejected from the lead-lined saturator by the aid of steam or compressed air, drained and dried in centrifugal apparatus.

Chemicals connected with the gas industry are chiefly exhibited by Messrs. Brotherton and Co., of Leeds; by the Gas Light and Coke Company, of Westminster, which shows a great variety of products; and by the British Cyanide Company, of Oldbury, near Birmingham; interesting novelties of the latter company are the refined potash products which were obtained by the company from blast-furnace dusts by the patented process of the British Potash Company, of the same address. As to various other chemicals, Messrs. Th. Morson and Sons, of Elm-street, Gray's Inn-road, W.C. 1, deserve notice. Messrs. J. H. Davis and Co., of the Macclesfield Patent Copper Sulphate Works, Widnes, give one of their exhibits of copper sulphate (for spraying) the shape of a crown built up of blue crystals. The samples of nozzles, mantle rings, rods, &c., of magnesia clay for incandescence gas lamp, shown by Messrs. Howlett and Co., of Birmingham, should also be examined.

The other main groupings of coal-tar products, dyes, is attractively and instructively represented by British Dyes, Limited, of Huddersfield, Messrs. Levinstein, of Manchester, and the London Dye Manufacturing Company, of Stratford; the two former firms have ample space at their disposal. The application of dyes is further exemplified on a great many other stands displaying textile goods, silks, calicos, yarns, felts, hats, flags, flowers, coloured paper, leather, &c. As to drawing inks and artists' colours we notice the British Drawing-Ink and Adhesive Manufacturing Company, of Great Ormond-street; Messrs. A. Johnson's pencil works, of Neasden; and Messrs. J. Rowney and Co., of Percy-street, W. 1 (waterproof inks). Hosiery needles are again exhibited by Messrs. L. Tansey and Co., of Hinckley, and also by Messrs. Grieve and Co., of Leicester. Sailcloth and materials for aeroplane wings are shown by Messrs. N. C. Thomson and Co., Limited, of 1, Bow-lane, E.C. 4.

The Morgan Crucible Company, Limited, of Battersea Works, S.W. 1, should have been mentioned before. Some of the graphite crucibles of various shapes and sizes (up to nearly 5 ft.) on view are for direct electric heating, the crucible serving both as container and as resister. The crucible shown is of vase shape and is provided with suitable extension pieces both at the top and bottom; these pieces are encircled by the ring electrodes through which the cooling water is circulating. A small crucible of the form described would take 150 lb. of metal, brass, copper, iron, steel, alloys,

&c.; but crucibles for charges of these metals up to 1,000 lb. have been constructed. In the tubular crucibles the ring electrodes are placed around the thickened extremities of the tube; such crucibles are utilised also for the reduction of oxides and gas reactions. The other exhibits exemplify the use of graphite for foundry facings, dynamo brushes, lubricators, &c.

Electric carbons for arc lamps, search lamps, magazine flame lamps, are only exhibited by one firm, well-known in this speciality, namely, the General Electric Company, of Witton, and Queen Victoria-street, E.C., who also explain the manufacture of the carbons by photographs and show various insulators, ebonite (made by the firm in connection with the Peel Conner Telephone Works, of Salford), vacuum-jacketed flasks and other apparatus. In the introductory article on Electric Light Carbons it is stated that the company had been working with losses which in 1914 aggregated over 70,000*l*. There is only one more graphite firm to be mentioned, the Cumberland Pencil Works, of Keswick.

Electric motors have, apart from the magneto machines already referred to, only one representative, the single-phase shunt commutator motor of Messrs. F. and A. Parkinson, of the Wells Works, Leeds, exhibited by Messrs. Pooling and Austin, of Westminster. The chief firms participating in the group exhibit of the British Ignition Apparatus Association are the British L. M. Ericson Company, of Coventry; E. I. C. Magnetos, Limited, of Birmingham; the M. L. Magneto Syndicate, Limited, of Coventry; Messrs. North and Sons, of Watford; Thomson-Bennett Magnetos, Limited, of Birmingham; and Messrs. C. A. Vandervell and Co., Limited, of Acton. Accumulators are absent, and as to primary dry batteries we will only express the hope that they will, on the whole, prove more reliable than some portable batteries did during the dark days of last winter. Insulating materials are shown by the British Ebonite Company, of 16, Victoria-street, and by some of the firms which we recently noticed. The fine display of crude and prepared rubber of Messrs. Harrison and Crosfield, of Great Tower-street, E.C. 3, comes mainly from the Malay Peninsula, Sumatra, and Ceylon; the St. Mungo Manufacturing Company, of Glasgow, merely shows samples and rubber erasers; the Palmer Tyre Company has some big and small motor and aeroplane tyres on view; and the North British Rubber Company, of East-road, N. 1, exhibits various rubber ware, shoes, boots, coats, tyres, hose, combs, diving dresses, &c.

The "ozonezer" or Quain silicon ozoniser of the Quain Ozone Syndicate, 17, Victoria-street, is described as consisting of a "vacuum tube made from quartz silica, through which the energy of the ultraviolet rays passes freely, while in other apparatus the brush discharge occurs and attacks the nitrogen, breaking much of it up into nitrous compounds"; the tubular ozonisers, characterised by these undoubtedly novel claims, are intended for the treatment of wounds and of tubercular and other diseases. As regards scientific instruments, the fine collection of standard binnacles, binoculars, sextants, prisms, lenses, barometers, protractors, &c., of Messrs. Heath and Co., New Eltham, S.E. 9, deserve mention.

We are tempted to conclude with a few remarks on exhibitions in general, not suggested by visits to the exhibition at the Central Hall. That exhibition will probably be followed by others, and when peace has been restored, industrials will be urged to display what they can achieve more particularly in the arts of peace, and not directly or indirectly connected with the war. Some industrials may readily acquiesce, others may join in the undertaking because they do not wish to stand back. The public, willing to attend in the hope of learning, frequently have reason to complain that more might be done to instruct and to interest them. The average exhibitor pays attention to a display worthy of his firm; but he wishes to do business, and he cares little to impart information. The expert and the customer know what to look for, and their questions will be attended to. The general visitor does not belong to either class and he leaves an exhibition tired and little the wiser. The technical press would like to do its duty. But general exhibitions claim more space than a journal can spare, a brief enumeration of the chief firms, dictated by a sense of fairness, is unsatisfactory, and definite questions as to the utility, mode of fabrication, and special features of an apparent novelty do not always receive the attention that would be given to purchasers. In reply to such questions trade circulars or price lists are sent, accompanied by the assurance that the firm will be happy to supply further information. A second request would not meet with more success, however. Nobody expects the revelation of trade secrets. If, however, Messrs. Hadfield do not consider that they are giving away trade secrets by exemplifying the compositions of their special steels, which have proved remarkably suitable for special purposes—as we stated last week—more firms might modify their views on what they regard as "trade secrets." For the initiated the analytical data would have been sufficient; but Messrs. Hadfield wish to assist the visitor, and the novel way of presenting their results cannot fail to impress upon the visitor how completely the properties of iron are changed by the addition of manganese and tungsten, and by the presence of very little more than the tolerable amount of phosphorus or sulphur.

The organisers of the exhibition at King's College which we lately noticed accentuated their desire to help the people to learn. Exhibitions of the class with which we are dealing are not supported by the State; large exhibitions generally receive subvention from public funds, and the public may rightly claim then that their interests should be guarded. In spite of all discussions on organisation, co-operation and scientific methods, however, the short-sighted shop policy which cannot see beyond immediate direct profits remains too prevalent. The stagnation and decline of certain British industries is not merely a result of foreign competition; the Chinese-wall policy of keeping knowledge to oneself bears a large share of the responsibility.

APPRENTICE CLUBS.

One of the most commendable features in the relationship of the employers to the workers is a more liberal conception on the part of the former of their duty in connection with the training of boys for industry. The new Education Act for England and the one now passing through the House of Commons for Scotland do much towards providing for a fuller training of boys. The age at which children can leave school has been extended, and at the same time limitations have been imposed on the number of hours boys and girls can work during the school period. Moreover, continuation classes are to be provided, and no doubt employers will see to it that those classes which are attended by young workers will have a curriculum in which due regard is paid to the claims of the industry pursued in their respective districts. There is undoubtedly a need for a closer interlacing of work and study, and we hope this need will be met. At the same time it is of the highest importance that in such vocational study there shall not be lost sight of the great importance of broader education, so that the coming worker may be able to have a fuller life, not only in having the guidance of literature, but also a higher conception of human enjoyments. Such training tends to better citizenship and more enlightened workmanship, and above all to truer ideals.

Many firms are at the present time organising schemes of training, associating the factory with the technical school, but for the reasons we have indicated more is needed, and we are therefore pleased to give in our present issue illustrations of one of the club houses for apprentices, which we are glad to realise are growing up in connection with some of our large industrial concerns. The four photographic views reproduced on page 436 illustrate rooms in the boys' club at Greenock which has been organised by the Scotts' Shipbuilding and Engineering Company, Limited, for the benefit of boys between the ages of 14 and 18 in their extensive works. The membership subscription is only 1*s.* per annum, and the proceeds are given as an annual subscription, in the name of the club, to the Greenock Infirmary. The club house was formerly a restaurant, but the rooms have been completely rearranged, furnished and equipped, so as to form a very attractive club house, which is open every evening except on Sundays. Fig. 1 shows the reading room and library, where there are picture books and light literature, and already a fairly large and growing collection of popular books. Fig. 2 shows a corner of the study. Here the boys are encouraged to do their home work in connection with technical classes, and not only is it thus possible for boys in large families to find the desired degree of quietude, but arrangement is made for some member of the Scotts' staff, who is qualified to give help and guidance to the students, to attend and assist every evening in connection with the class work. Fig. 3 shows the recreation room and Fig. 4 the gymnasium. In both cases, particularly in the case of the gymnasium, there is an instructor to assist in developing mental and physical enjoyment. Indeed, a regular course is provided by the gymnasium teacher. In this room, too, there are given periodical concerts, cinematograph and magic lantern shows, with occasional lectures and other entertainments, all designed to help the boys.

The important rule is made that in this club house there shall be no association between the life of the boy there and his work in the factory; in fact except in the study all "shop" is "taboo," a very commendable feature. There is provision made, however, for the boys pursuing hobbies, and to this end lathes are set up where anyone can carry out recreative work of a mechanical character, scraps of metal from the yard and foundry being salved and sent to this workshop for the use of the members. Here, again, the aim is to make the work purely recreative.

INDUSTRIAL NOTES.

Speaking last week at the annual meeting of the Birmingham Small Arms Company, Limited, Sir Hallewell Rogers said that the manufacture of rifles, military bicycles and motor cycles had been carried on unremittingly since the beginning of the war. Perhaps the most striking product they had been and were producing was the Lewis machine gun.

About three months ago an attack was made on the Government, and the authorities were severely censured for not adopting another pattern machine gun. The authorities met this attack by inviting a test of various patterns of machine guns before a committee of experts, who, by a unanimous decision, placed the Lewis gun at the top of the list, thus providing a very crushing reply to what, he thought, might be regarded as interested criticism.

Prominent in the war work of the Daimler Company was the manufacture of aeroplane engines and aeroplanes on a very large scale indeed.

The extraordinary increase in the volume of their manufactures had been accompanied by a corresponding increase in the size of all their factories and their equipments.

One item in their programme, from which they anticipated good results was that, in association with the Metropolitan Carriage, Wagon and Finance Company, they were actively interesting themselves in a line of manufacture forming a "key industry," for which in the past manufacturers had almost entirely been dependent upon importation from other countries.

The British Manufacturers' Corporation have issued the report of the proceedings of the preliminary meeting, held in Manchester, on September 17, together with the address of Sir Charles Mandleberg, the chairman.

The object of the corporation is to arrive at concerted action by manufacturers with a view largely to increase the British export trade after the war. In the course of his address, Sir Charles pointed out that the national as well as the manufacturers' own interests demanded prompt and vigorous action, since a large increase in our export trade meant more revenue to meet our enormously increased taxation, and also more employment at a period when the needs of our returning troops and the needs of all now employed in industry would constitute a grave labour problem.

The scheme is to be established on national lines, and aims at placing all British manufacturers, by co-operation, in a better position to increase their turnover. It is to be an association of British manufacturers and producers of, probably, 1,000 members, each subscribing 100*l*. or 200*l*. a year, which would give an annual income of 100,000*l*. or 200,000*l*. per year. With such an amount at their disposal, the corporation, Sir Charles stated, would be able to secure the highest class of representatives to act as their men-on-the-spot

in those parts of the world in which it was determined to do business.

The proposals were entered into in detail, and the corporation was formed with Sir Charles as chairman, Mr. Colin Cooper as hon. secretary (*pro tem.*), and a provisional committee. The latter assembled after the meeting, to consider the immediate programme and make the preliminary arrangements. The temporary offices are at 60, Spring Gardens, Manchester.

In view of an important conference which is to take place at Birmingham on November 12, between representatives of the Ministry of Reconstruction, and representatives of the brass and copper trades, the following facts may be of interest:—

The motive of the conference is to discuss the formation in the brass and copper trades of an Interim Industrial Reconstruction Committee. These Interim Committees, of which some 20 have already been formed, are designed by the Government to serve in the less highly organised trades in the place of the full Industrial Councils or Trade Parliaments which the Whitley Report recommended. But these will only be temporary; that is to say, only until such time as the trades have reached a sufficient degree of organisation to make possible the establishment of full Industrial Councils. The Interim Committees are formed on much the same lines as the full Industrial Councils. They are composed of an equal number of representatives of employers' associations and of workers' unions. Their duties, so far as concerns the industrial period immediately following the war, are almost identical with those of full Trade Councils. In fact, the whole idea is that the Interim Reconstruction Committee in any trade shall be a stepping-stone or half-way house to a full Industrial Council for that trade.

The Government's negotiations so far with regard to the brass and copper trade may be summarised as follows: An informal conference of the trade was held in Birmingham on July 17, when among the questions discussed three attracted considerable attention, namely the demarcation of the boundaries of the industry, the grouping of the trade and the further organisation of the trade as a whole.

To obtain a well-considered view of these questions a small Advisory Committee was appointed with Mr. E. G. Harcourt as chairman. This committee has now presented a report, and the conference to be held on November 12 will be for the purpose of considering its recommendations. Invitations will be issued by the Minister of Reconstruction, under whose auspices the conference is being held, to all the trade associations and trade unions concerned in the industry.

One question to be considered will be the position of metal merchants, dealers and brokers, and also of export merchants. Associations of merchants are being invited to send representatives to the conference. But as possibly some associations may be overlooked it is desired that any association, whether of merchants or manufacturers, which can claim an interest in the trade should have delegates at the conference, so that the opinion of the whole trade may be fully representative.

Inquiries concerning the conference should be addressed to the Secretary of the Trade Organisation Commission at the Ministry of Reconstruction, 2, Queen Anne's Gate Buildings, Westminster.

The situation which may result at the end of the war in regard to the various wages awards which have been made during the war has for some time been under the consideration of the departments concerned. The present scale of wages in many occupations depends upon the compulsory enforcement of awards which were made in view of circumstances arising out of the war; but the machinery for enforcing these awards will not continue after the war. It is necessary, therefore, to consider whether the compulsory operation of such awards should be continued during a period of transition after the war and also whether the power to make such awards should be extended so as to cover the same period.

With a view to immediate action on this most important subject, the Minister of Reconstruction, with the concurrence of the departments affected, is appointing a committee with the following terms of reference:—

1. Whether the compulsory operation of awards made under the Munitions of War Acts, of Orders extending such awards, and of Orders regulating wages made under those Acts should be continued after the war.

2. Whether the power to make such awards or orders should be continued after the war.

3. The manner in which awards and orders if made or continued should be enforced after the war and for what period.

The Right Hon. Sir John Simon, K.C., M.P., has been asked to act as chairman of the committee, and he has made arrangements to do so. The committee will consist of representatives of employers and trade unions besides representatives of the Government Departments concerned.

An award has just been issued by the Committee on Production under which an advance of 10 per cent. has been granted in the case of shipwrights on the North-East Coast (Tyne and Blyth districts). In 1917, a piece-work list was arrived at by agreement between the parties and by arbitration, and the present advance, which is to operate as from the first full pay following August 2, 1918, is an advance upon that list.

The Director of the Department of Labour Statistics writing in *The Labour Gazette*, says that in September employment continued to be very good in most industries, and in many of them much overtime was worked. In the cotton, linen, jute and certain other textile industries, however, there was short time.

Trade unions with a net membership of 1,139,090, excluding those serving with the Forces, reported 0·5 per cent. of their members as unemployed at the end of September, compared with 0·5 per cent. at the end of August and 1·3 per cent. at the end of September, 1917.

Of the 3,921,878 male and female workpeople insured under the National Insurance Acts of 1911 and 1916, the number unemployed at the end of September was 26,208 (or 0·67 per cent.), compared with 0·66 per cent. in the previous month, and 0·71 per cent. a year ago. For males and females separately the percentages unemployed at the end of September were 0·31 and 1·40.

The average weekly number of vacancies notified to all Employment Exchanges for the four weeks ended September 6, 1918, was 42,627, as compared with 40,010 in the previous four weeks, and with 38,133 in the four weeks ended September 7, 1917. The average weekly number of vacancies filled for the same period was 33,373, 30,279, and 29,363 respectively. The number of workpeople remaining on the live register at September 6, 1918, was 28,254 men, 53,304 women, 8,049 boys, and 8,081 girls—a total of 97,688.

The principal changes in rates of wages (including war bonuses) reported to the department as having occurred during September were increases of 5*s.* and 2*s.* 6*d.* per week granted, under an Order of the Ministry of Munitions, to women and girls, respectively, on munitions work; increases of 3*s.* 6*d.* and 1*s.* 9*d.* per week to men and boys, respectively, employed as woodworkers, painters, polishers, dopers, &c., in aircraft establishments; increases of 5*s.* per week for men and women, and 2*s.* 6*d.* per week for boys and girls engaged in the railway service on the manipulation of traffic; and a further advance of 5*s.* per week to carters in a large number of districts. Other important changes affected men engaged in the production of leather, workpeople in the dressmaking and millinery trades in London, and printing trade operatives in London and various other towns.

The number of trade disputes beginning in September, was 101, and the total number of workpeople involved in all disputes in progress was 205,000, as compared with 227,800 in the previous month, and 77,800 in September, 1917. The estimated total aggregate duration of all industrial disputes during the month was 831,300 days, as compared with 707,900 days in August, 1918, and 615,100 days in September, 1917. The principal bodies of workpeople involved were operatives in the cotton spinning industry in Lancashire and Cheshire, and railway workers in South Wales, Monmouthshire and certain other districts.

The Committee on Production have issued their award on the demand for a minimum rate per week of £5 for shipwrights in the Clyde, Barrow, Aberdeen, Dundee and Leith districts. The men's claim is not conceded. The Committee have not conceded either a similar claim put forward on behalf of the joiners and wood-cutting machinists of the same districts.

The parties making the claim were the Shipbuilding Employers' Federation and the Ship Constructors and Shipwrights' Society. The Committee, who have arrived at the above negative conclusion, state that the time rates of the men concerned compare favourably with the time rates of other classes of workpeople in the districts named, and with similar classes of workmen in other shipbuilding districts. The men concerned have received the usual war wage advances given under the general awards of the Committee on Production, amounting to 23*s.* 6*d.* a week over pre-war rates, and they have also received a bonus of 12½ per cent. on earnings given under Statutory Orders made by the Minister of Munitions and the Admiralty.

The Committee further state that in accordance with the existing arrangement for the periodical consideration of wages questions affecting the whole trade, notice has been given by the Trade Union Committee of an application for a further increase of wages, and to make now an award confined to specific districts would prejudice the hearing of this application, which has been fixed for October 24. The circumstance that the weekly earnings of the men are lower than those of certain other trades in shipyards, or of men in the same trade in other districts arises, the award adds, from the fact that the men have not, in a general way adopted a system of payment by results. The Committee have arrived at the conclusion, and they so award, that the claim for the minimum time rate of wages asked for is not one which can be conceded. So far as the claim is based on the increased cost of living due to the war, the case is covered by the arrangement in force for the periodical review of wages, under which a further claim has recently been submitted, and will be heard shortly. So far as the claim raises the question of present earnings, apart from war wages payments, the Committee do not feel that it can be properly dealt with without at the same time making some provision to secure that measure of output which is essential in the national interest.

Col. Will Thorne, M.P., states that an agreement has been reached between gas undertakings and gas employees in connection with the demand of gas workers for an increase of wages of 10*s.* a week for men and women over 18, and of 5*s.* for employees under that age. The settlement provides for an advance of 3*s.* 6*d.* per week, or 7*d.* per day or shift, for men and women and half that amount for younger employees, with corresponding advances to piece workers. The agreement affects over 100,000 persons throughout the country.

President W. H. Finley, of the American Association of Engineers, announces the appointment of a committee of engineers to study after-war conditions. The committee, says *The Iron Age*, consists of Isham Randolph, chairman; Edmund T. Perkins, consulting engineer, Chicago; Governor S. Williams, consulting engineer, Ann Arber, Mich.; and Samuel Morell, Chicago, secretary. The committee will be increased as it gets into the work and will join forces with other agencies in Chicago and throughout the country that are now studying the problem. It plans to consider the demobilised soldier and his return to the industry which best suits his capacity and desires. It plans also to study the better use of our natural resources in lands, minerals, waters and forests, to furnish opportunities for each citizen and the placing of industry, agriculture, mining and transportation on a basis to meet the changed needs of the country.

Anti-German Industrial Development in Switzerland.—German papers acknowledge that during the war the industrial developments in Switzerland have taken up a decided anti-German trend. Prior to the war Germany was by far the largest purveyor of industrial products to Switzerland; German goods were entirely to the fore in many branches, and German commercial travellers visited the country in large numbers. Even before the war a movement against the German commercial invasion had manifested itself, and right-minded Swiss strongly urged their country to adopt a more independent attitude. Measures are now clamoured for which are intended to favour the home industry as against foreign undertakings, and steps have also been taken which the Germans are inclined to call non-neutral. Active work is in process, it would appear, to close as much as possible the Swiss market to Germany in favour of France and the allied countries. Germany is blamed in Switzerland for illegal competition and for underselling the home industry.

British Institute of Industrial Art.—The Board of Trade, in conjunction with the Board of Education and with the advice of representative members of the Royal Society of Arts, the Arts and Crafts Exhibition Society, the Art Workers' Guild, the Design and Industries' Association, and various persons and organisations connected with manufacture and commerce, have framed a scheme for the establishment of a British Institute of Industrial Art with the object of raising and maintaining the standard of design and workmanship of works and industrial art produced by British designers, craftsmen and manufacturers, and of stimulating the demand for such works as reach a high standard of excellence. The Institute will be incorporated under the joint auspices of the Board of Trade as the department dealing with industry, and the Board of Education as the authority controlling the Victoria and Albert Museum, and the methods by which it is proposed to achieve its objects include: (*a*) A permanent exhibition in London of modern British works selected as reaching a high standard of artistic craftsmanship and manufacture; (*b*) a selling agency attached to this exhibition; (*c*) a purchase fund for securing for the State selected works of outstanding merit exhibited at the Institute; (*d*) the establishment of machinery for bringing designers and art workers into closer touch with manufacturers, distributors and others; (*e*) the organisation of provincial and travelling exhibitions of a similar character, either directly or in co-operation with other organisations. All communications should be addressed to the Secretary, British Institute of Industrial Art, Board of Trade, 7, Whitehall Gardens, London, S.W. 1.

INDUSTRIAL COAL ECONOMY.

At a meeting of the Association of Engineers-in-Charge, held on Saturday last, the 12th inst., at the St. Bride's Institute, the president of the association, Mr. Frank Bailey, M.Inst.C.E., M.I.E.E., occupying the chair, an address was delivered by Mr. David Wilson, the Technical Adviser to the Coal Controller, on the subject of "Industrial Coal Economy." Of this address we subjoin a full abstract. The subject dealt with is one of paramount importance at the present time, and Mr. Wilson's position enables him to speak with authority, so that we feel sure that the views he expresses will receive the special attention which they deserve.

I do not come here claiming any super-knowledge. I am sure that most of you must know as much about the scientific combustion of coal as I do, but it has been my good fortune to travel all over the world in connection with this particular section of science, and this, in conjunction with the general survey which I am making for the Coal Controller, enables me to take a much broader view of the situation than some of my less fortunate colleagues, whose experience by force of circumstances has been confined to a more limited radius.

I attach the greatest importance to the value of travel, and if you, gentlemen, cannot go abroad, you should at least make an effort to cover as much of the field in your own country as is possible, and by so doing, I am sure you will find, as I have found, that amidst the maze of side paths which many are following, there is a broad main road along which the army of progress will eventually march. In other words, by obtaining collective first-hand information you are able more accurately to gauge the limitations of the side paths and to better standardise the main effort. If I may say so, I think there has been a little too much selfish pride in individual effort, and whilst I know that there has been a great advance in the direction of co-operation during recent years, I think there is yet much to be done by engineers-in-charge visiting power stations and works all over the country, and ascertaining exactly what is going on.

To come now to the specific point of my mission here to-night, I would say that it is my desire to confine myself as far as possible to suggestions which might materialise in the immediate future, and so help as far as our efforts are concerned, to help win this war—the wish which I know is predominant in all your minds—and I leave the larger economy suggestions which embody reconstruction, &c.—and must therefore be post-war—to gentlemen like your worthy president, possessing far greater knowledge and experience than myself.

The total consumption of coal in the British Isles during the year 1917, can be taken at approximately 180,000,000 tons, and of this amount, approximately 7,500,000 tons were consumed by the electrical industry, or, say, 4 per cent. The total number of units generated during 1917 were approximately 5,000,000,000, so that the average efficiency is represented by a figure of 3·36 lb. per kilowatt-hour generated. The total coal used by industrial firms, exclusive of railways, coasting steamers, gas works and domestic purposes, is approximately 100,000,000 tons per annum, and of this, it is estimated that 80,000,000 tons are used per annum directly for power production.

Bearing in mind, therefore, that the electrical industry is collectively the most efficient consumer of coal so far as steam-raising is concerned, we cannot expect from this industry any great reduction in total tonnage as a result of further economy, but as the last man may decide the war, so may the last ton of coal be of supreme importance, and the man who can save, where it is difficult to save, is to my mind doing more noble and patriotic work than the man who has simply to wake himself and by correcting his own gross neglect in the past, produce a very large saving.

Now you naturally ask me, what more can you do to help, and I will endeavour to answer you.

1. *Find out Definitely what you are doing.*—This sounds very commonplace, but if that advice is acted upon by everyone, I am absolutely certain that enormous savings in coal will result. Before I joined the Coal Controller, I knew that the absence of detailed information was responsible for a great wastage of coal. The electrical industry has done well in establishing detailed records, but the want of definite knowledge regarding the working of steam plants in many industrial undertakings is deplorable.

My mission with the Coal Controller has confirmed my opinion beyond any question of doubt. We sent out a simple questionaire to all industrial firms in the country, and if the answers had been even approximately correct, I could have put my finger on each inefficient works. What happened? The efficiency information in the majority of cases was obviously inaccurate, and I discovered afterwards that a great number of the firms had simply approached the boiler contractors or insurance companies and asked them what number they should multiply the coal tonnage by, to get the evaporation figure. I, of course, fully appreciate the difficulty involved in establishing and maintaining records, but the best-managed electrical undertakings have succeeded in doing this thing, and it should be possible for all industrial firms at least to approach the methods of the key industry. I hold, and I think you will agree with me, that no one should be allowed to use up one of the country's most valuable assets unless he can show that it is being used efficiently. The Coal Controller's records show that even the electrical industry can do much more in this direction. Coal consumptions vary from 2 lb. per unit to 18 lb. per unit, and the thermal efficiency from 3 per cent. to 16 per cent.

The common reply from the inefficient station is that the bad results are due to poor load factor, obsolete plants, &c., and whilst we fully appreciate the importance of such factors and make due allowance, many engineers are too ready to attribute the whole of the inefficiency to these conditions—the detailed supporting evidence being in a great many cases based on pure assumption. How many engineers could supply the detailed information such as the Victoria Falls and Transvaal Power Company tabulate each week?—details which enable that company to keep a very close check on each particular section of the plant. It means a considerable amount of trouble, but it is worth the trouble. It is forthcoming from many stations; it should be forthcoming from all stations.

I am sure your president could give you not only the correct average steam consumption of his station, and the average efficiency of the boiler-house, but also the individual steam consumption of any engine or turbine, or the efficiency of each individual boiler. When such information is obtained regularly, I am confident that the engineer who based his conclusions more or less on assumption, will find that after making due allowance for poor load factor, obsolete plant, &c., there is a large unaccounted-for loss which should not exist. Therefore I say that the first thing to do is to establish definitely what each section of the plant is doing—in other words, make certain that no section of the plant is eating more than its allotted ration of British thermal units, claiming no certificate for excess ration, unless there is proof as to the nature and extent of the disease in the case of crocks.

2. *Staff.*—It is needless to say that close co-operation between engineers and managers and the men who actually fire the coal, is essential, and whilst such co-operation already exists in several works, it is unfortunately a fact that in many establishments, no interest whatever is taken in the fireman or his work. His selection is often decided more on account of his muscular attainments than upon his ability to burn coal efficiently. A good steam pressure line is often sufficient for promotion, irrespective of the man's methods, which in many cases may be confined and directly equated to his muscular powers.

If all coal used for steam raising was consumed on scientific lines, the saving to the country would represent many millions of tons per annum, and whilst this fact is well known, I believe that much could be done at once to assist the present coal situation by getting engineers to devote more time to the boiler-house. America has done much in this direction, and the late Mr. Stott, engineer of the Rapid Transit Railway, New York, was, before he died, seriously considering the employment of trained engineers actually to control the individual furnaces. The cost of such a staff is relatively unimportant when you consider the coal saving which is possible, but whether or not Mr. Stott's ideals are necessary, no boiler-house of any size should be without some staff fully trained in the scientific combustion of coal. It is difficult to increase the staff under present conditions, but I suggest that during the coal crisis, engineers-in-charge should devote as much time to the boiler-house as possible, and make a special effort to impart the super-knowledge which they possess, to the fireman. I know of one power station where the engineer-in-charge is giving weekly lectures to the firemen, which are greatly appreciated and producing improved results in the boiler-house. I suggest that a course of such lectures should be given to every boiler-house staff, and I shall be pleased to forward information suitable for such lectures, to engineers desiring same.

3. *Boiler-House Equipment.*—Just as the workman cannot do justice to his labour without the proper tools necessary for his particular trade, neither can the engineer find out definitely what each section of his plant is doing unless he is supplied with the necessary apparatus. This again sounds very commonplace, but I would ask you to remember that I am speaking with a good deal of recent inside information as to what is going on around the country, and have a definite object in emphasising these points.

Much good can be done with simple and obtainable apparatus, and when I tell you that relatively few works possess even the pyrometer, draught gauges, &c., necessary for intelligently controlling efficiency, you will agree that there is much ground to cover before we can say that everything possible is being done. Works which are doing well now, can only do better by going even more closely into details, and this means establishing a further subdivision of records. If the average efficiency is going to be raised, the daily performance of each individual boiler should be very closely watched, and for this purpose every boiler should be equipped with a draught gauge so that the fireman can correctly adjust the air supply and the fire bed to give the best results. Every plant should have some simple form of CO_2 analyser for obtaining a knowledge of the conditions existing within the furnace, and whilst it is too much to expect in these times that a recorder be fixed to every boiler, one or two "Orsat" sets should be in daily use in every boiler-house—an inexpensive piece of apparatus and reliable.

Again, whilst we would like to see a pyrometer fixed in each boiler or economiser outlet, I appreciate that it would be difficult to obtain a sufficient number just now, but much can be done with a few pyrometers, and there is no reason at all why works should be without some fairly reliable data as to the temperature of the escaping gases—yet it is the exception rather than the rule to find such data.

When we remember that a record of the CO_2, the escaping gas temperature, and a close inspection of the ash heap, will give a very good idea of the thermal efficiency, an effort should certainly be made to establish such data in all cases where it is not forthcoming at present. In some works, the average for the complete plant is taken, and in such cases I suggest that further economy will follow the close study of each individual unit, and the boiler-house equipment should be sufficient to enable this to be done.

4. *Engine-Room Equipment.*—Here, again, I think that arrangements should be made for more accurately determining the actual steam consumption of the individual plants. In too many cases do I find that the figures are simply based upon contractors' original guarantees. There is apparatus on the market for correctly recording the hourly consumption of each plant and some stations, such as the London County Council, Greenwich, have installed such apparatus on each individual unit. The plant would not be forthcoming for any large general application at the present time, but there are other simple methods which can be introduced by using existing tanks, &c., and I am sure your president could give you useful advice in this direction.

5. *Coal.*—I know that here, I touch dangerous ground, and I anticipate your question "What is the good of discussing efficiency when the quality of coal is so variable?" With all due respect, I do not think anyone should approach the problem in that spirit. The Coal Controller fully appreciates the importance of selected distribution, but we are at war, and the present coal crisis confines us very largely to a question of supply and demand. When things are again normal, I am confident that an effort will be made to distribute coal on a basis which will combine the interests of the country and the consumer—in fact, I would personally like to go beyond this and make a compulsory allocation of the highest grade coal to firms remote from the coalfield, using the lower-grade fuels at works nearest to the collieries.

To my mind, there is no question that the highest thermal efficiency is obtained when burning the highest quality of coal, but the commercial economic result may be in favour of the low-grade fuel at works where it can be obtained at a low enough price. I have obtained the same thermal efficiency on test with low-grade fuel as with high-grade coal, but with the latter, the good results are maintained automatically after the proper conditions are established, and in this direction the close supervision of the fireman is not so necessary, but with the low-grade fuel, the fire requires constant attention if the same high efficiency is to be maintained. Whilst, therefore, it is quite possible to show approximately equal results on test, the difference on a month's run may be as much as 10 per cent. to 15 per cent., depending upon the amount of attention given to the fires by the boiler-house staff. Many of you may be called upon to burn low-grade coal for the period of the war, and it is therefore all the more necessary that the engineer should devote as much time as possible to the boiler-house.

Whilst I have given my own opinion about the effect of quality of coal on efficiency, I would remind you that some of the best stations in the country have established high thermal efficiencies when using low-grade fuel. For instance, the highest result on record is at an electric power station in the North of England giving an overall thermal efficiency of 16 per cent., using coal having an average calorific value of 10,000 British thermal units per pound. Again, the Victoria Falls and Transvaal Power Company use coal having a low average value, and a large quantity having a value of only 7,000 British thermal units, and as I have previously stated, their results are excellent.

Low-grade fuel cannot therefore be taken as a complete explanation of the serious inefficiency of many works, and it is the duty of every engineer to satisfy himself that he is utilising the maximum possible percentage of British thermal units in the coal, whatever the calorific value may be. Our main object at the moment is to "Carry on," and the allocation of different coals has for the present, unfortunately, to be largely governed by that factor. There is barely sufficient quantity of the high-grade coal to supply the full requirements of the most essential industries, and in addition to improving efficiencies, every engineer can do further patriotic work by making an honest attempt to "Carry on" with the lowest grade possible, thereby releasing further quantities of the higher grade coal for firms in most urgent need of same.

6. *Anthracite.*—Whilst there is a general shortage of other fuels, there is a considerable quantity of Anthracite Rubbly Culn available for those who can use it. Anthracite fuel, as you are aware, has a high calorific value, and the limitation in its use is due to the fact that it requires more draught to burn it, and a big allocation can only be made to firms who have ample boiler margin, or special furnaces fitted with forced draught. I believe, however, that the majority of firms could take a small percentage of this fuel to mix with the more bituminous fuel, irrespective of the boiler margin or type of furnace and I suggest that in this direction you can all assist the Coal Controller by making a special effort to burn as large a quantity of anthracite fuel as possible. If there is any difficulty in obtaining from your Coal Contractors the quantity which you desire, you should immediately write to the Coal Controller, and the matter will receive, immediate attention.

7. *Coke Fuel.*—It is obviously to the advantage of the nation to consume as much coke as possible in lieu of coal, as in the preparation of coke, all the valuable by-products are recovered. There has been far too much prejudice in the past in connection with the burning of coke fuel, and reviewing the Coal Controller's campaign in this particular direction, it is surprising to note the quantity of coke which is now being consumed at works where the managers had hitherto claimed that such fuel was totally unsuitable. There is still a big difference

of opinion as to the thermal and commercial efficiency of coke fuel, but regarding the former, I am quite clear in my own mind. On a hand-fired boiler, a distinct thermal advantage is obtained by using coke, for the simple reason that the hydro-carbon loss which immediately follows the firing of bituminous coal, is obviously absent in case of coke.

With many types of mechanically-fired boilers, that is, boilers equipped with stokers which consume the hydro-carbon gases, this advantage does not occur, but in both cases the use of coke fuel is limited by the quantity which can be consumed per hour on a given grate area and with a given draught. On many boilers where the draught is insufficient, steam jets have been applied with fairly satisfactory results, but in such cases it is very necessary to ascertain accurately the amount of steam used in producing this extra draught.

Mechanical stokers have been designed for burning coke fuel alone, and there are several installations throughout the country where information can be obtained as to the possibilities in this direction. Quite apart, however, from these special appliances, a large number of firms are now assisting the coal situation by burning a percentage of coke fuel mixed with coal. In many instances the two fuels are simply mixed in the bunkers, and the amount which can be used in this way without reducing the output of the boiler plant, seems to vary from 5 per cent. to 50 per cent.

The London County Council are now consuming considerable quantities of crushed coke on chain-grate mechanical stokers. In one section of the plant they are burning coke fuel alone, and in another section of the plant they are experimenting with coke fuel mixed with coal on what is known as the "Sandwich" system. This system consists in placing a division plate in the stoker hopper. The coal is fed into the back portion of the hopper and the coke into the front portion, so that the combined fuel enters the furnace in two distinct layers, the coal being on the top. The volatile gases given off from the bituminous coal on the top, maintain the firebrick arch in an incandescent state, thereby establishing early ignition of the fuel bed at the fire door. The results obtained from this system are most promising, not only at the London County Council works, but also at other works throughout the country, where the same arrangement is being tried. I believe that the London County Council engineer has succeeded in burning a half-and-half mixture of coal and coke in this way, without suffering any appreciable decrease in output.

There is still a considerable surplus of coke breeze available in London, and in different parts of the country, and I cannot too strongly emphasise the importance of every engineer doing his utmost to burn some quantity of this fuel even if this means inconvenience in some cases, and possibly extra labour in dealing with the ash and clinker, bearing in mind that any such help is of very direct benefit to the nation during the present coal crisis. Here, again, I need hardly say that the Coal Controller will be only too pleased to give every assistance both as regards supplies of this fuel, and also the best methods of burning it.

8. *Calorific Values.*—I think it is of the utmost importance that every engineer should make some attempt to ascertain the calorific value of the coal which he is using, otherwise it is quite impossible intelligently to consider efficiency results.

In America it is now quite common practice to buy coal on the British thermal unit basis, and I hope that the time will come when all coal in this country is purchased on this basis, which after all is the logical basis, but that time is not yet, and in the meantime I strongly suggest that engineers help themselves by giving more attention to the calorific value of fuel. Every power-house should possess a calorimeter and the necessary apparatus for obtaining the approximate analyses of coal. The whole outfit can be obtained on an expenditure not exceeding 20*l*. It must not be assumed that a chemist is essential for making such approximate analyses—any engineer can very quickly train an assistant to do this work accurately.

The standard calorimeter is, of course, the Mahler bomb oxygen apparatus, but this is rather expensive, costing, I believe, some 40*l*. I use a sodium peroxide bomb calorimeter, which costs about 6*l*. 10*s*. Given a careful and intelligent operator, reliable results are easily obtainable from the calorimeter, and I am quite satisfied that the greatest difficulty in obtaining accurate determinations is confined to the sampling of the coal, both in the boiler-house and in the laboratory.

Of course, I quite appreciate that it would be impossible to procure calorimeters for all boiler houses at the present time, but some attempt should be made by everyone to establish a British thermal unit record of the coal used, and failing the possession of an instrument, I suggest that regular samples be sent to some recognised testing laboratory. If this latter suggestion is not acceptable, then I would recommend the "Litharge" method of coal testing. This is not an absolutely reliable method, but it is certainly better than doing nothing at all.

Electrical engineers throughout the country have for some time been making close comparisons of thermal efficiencies, and further comparisons are now being made by the Board of Trade, Coal Mines Department, but I have pointed out on many occasions the importance of every engineer giving closer attention to the calorific value of fuel used, as obviously the value of such comparisons must naturally depend upon the soundness of this foundation.

9. *Efficiency.*—Whilst it has been possible to obtain a fair idea of the average thermal efficiency of the electrical industry and also the individual efficiency of each electricity works owing to the ease with which the various factors can be equated, it is practically impossible to obtain even a fair approximate estimate of the efficiency of industrial firms due firstly, to the entire absence of the necessary data in the case of many firms and, secondly, to the difficulty in equating the numerous factors involved. I think, however, that a rough guess of 50 per cent. boiler efficiency would certainly not be too low, and when we bear in mind that many individual experts have established that a modern boiler unit complete with stoker, superheater and economiser will give a combined efficiency of at least 80 per cent. on test, it behoves us fully to explore the margin of difference between test conditions and actual working conditions, as we find them throughout the country.

In the first place there is the question of incomplete design, in other words, there are far too many boilers around the country installed without stokers, superheaters or economisers—boilers which are discharging gases of high temperature to assist in warming the atmosphere generally, and as opportunity offers, steps should be taken to complete such installations so that the final temperature of the gases entering the chimney does not exceed 350 to 400 deg. F. Secondly, much of the difference is entirely due to insufficient supervision. I quite realise that it would not be possible to have the same close supervision all over a boiler-house, as is possible on one individual unit during a test, but I have already given my opinion regarding boiler-house staff, and I suggest that it is possible to bring up the average efficiency of the boiler-house to a figure more closely approaching that of the test conditions.

10. *Feed-Water Temperatures.*—You all know the importance of obtaining a high feed-water temperature. It is estimated that, speaking generally, 1 per cent. of fuel is saved for every 11 deg. rise in the feed-water temperature, provided the heat producing this rise in temperature would otherwise be wasted, yet I regret to say that in a great many works, heat is being thrown away which could easily be recovered for heating the water. Only this week I had a case before me where pure hot water was being discharged into a drain to an extent which, if directed to the boilers, would produce a saving of 15 per cent. in fuel.

The exhaust from at least a portion of small auxiliary plant, should be directed through an oil separator, to the feed-water tank, rather than to a condenser, until a maximum temperature of, say, 200 deg. F. is obtained, and in the case of reciprocating engines, it is often more economical to give the feed-water temperature first consideration, in preference to high vacuum; in fact, I predict that the whole question of exhaust steam heating will receive consideration in the future, which will not be limited to the confines of the power station, but will extend to the possibilities of domestic heating, &c., in a way which may completely revolutionise our previous ideas.

When we think of the billions of latent British thermal units in the condenser cooling water which are daily discharged to heat our atmosphere and rivers, for no beneficial purpose, and remember that the recovery of this waste would enable us to utilise from each pound of coal at the very least 50 per cent. of the heat energy contained therein, instead of the present miserable maximum of 18 per cent., we ask ourselves whether after all we are not working at the wrong end of the stick. However, I am wandering into the realms of prophecy which cannot materialise in time to help the Coal Controller in his immediate mission, and for the present it behoves all of us to finish and polish the end of the stick which is available to us, until it can be considered a finished article. Therefore, I say that many firms can help by giving more consideration to the question of feed-water temperatures, satisfying themselves that all exhaust steam, steam-pipe drainings, &c., are used to the best advantage.

11. *Boiler Blow-down.*—Arising out of the above, I would briefly refer to the B.T.U.'s discharged during the operation of "blowing down" boilers. We are really barbarous in our treatment of the innocent "B.T.U." We first try to cremate him, and whilst numbers get past our sentries and escape up the chimney, others who have remained to do a bit more fighting in the first trench, are promptly captured and pushed down a drain pipe to be effectively suffocated—whilst the astral bodies of the remainder, pass on to the engine only to find large battalions thrown into the river to meet final death by drowning. "Blowing down" boilers is of course essential, but the amount necessary, naturally depends upon the care given to water treatment.

In conclusion I would ask to be allowed to say a very few words about my mission with the Coal Controller. In a free country such as ours, we all detest the necessity of Government control, and I am sure that no one detests this necessity more than Sir Guy Calthrop. One of his many functions is to see that as far as possible the available supplies are distributed to the best advantage, and that each person does his full bit in sharing equally any hardship, inconvenience, or loss, which may follow for a time, in order to meet the country's needs.

I can assure you that the Controller has always been most anxious to reduce inconvenience to a minimum, and at the very beginning he desired the assistance of some person who could stand between him and the consumer, firstly to advise and protect him against any unjust technical opposition on the part of the consumer as to the allocation of coal, and secondly to protect the consumer against the allocation of any particular coal which might be totally unsuitable for the requirements of the particular industry.

During the past year I have investigated 3,100 cases on behalf of the Controller and I would say that the majority of the complaints could not be substantiated. Here therefore, you have one of the things which make control a necessity. Every technical complaint received by the Controller has received most careful consideration, and wherever necessary, a technical representative has actually visited the works and considered the conditions on site, so that the Controller received detailed and accurate guidance as to his decision.

He has also recognised that whilst so many are doing their utmost to help, there are others who are not doing their full share, and in fairness to the former, he is anxious to see that the whole team pull together, and when this is achieved, a very considerable saving in coal will result to the benefit of the Nation and the consumer individually. He has therefore started a Coal Economy Campaign, and whilst it has only been in operation for a short time, the prospects are quite hopeful. It will be necessary to investigate 36,000 cases, and out of 364 works visited during the first few weeks, a saving of 106,000 tons per annum is estimated.

We do not look upon the scheme of procedure as ideal. It is quite recognised that much more perfect arrangements could be made, but we have been guided by the fact that whatever is done must be done quickly, in order that any success obtained may benefit the coal situation in the near future. 400 engineers have very kindly given their part services voluntary, and these gentlemen will each actually visit a group of firms within their local radius reporting to Headquarters any evidence of inefficiency and answering a detailed questionaire which has been specially drafted for the purpose. I have at Headquarters a staff of assistants who are specially qualified in matters connected with coal economy, and each individual report will receive our careful scrutiny before I report to the Coal Controller.

We would naturally like to see experts or Economy Committees appointed for each separate industry—men possessing a detailed knowledge of each special manufacture, but the war would be over before we could establish such an organisation, and for the present we have selected engineers who by virtue of their training are more particularly qualified in the efficiency of power production, at the same time making every effort to strengthen the organisation by selecting gentlemen for special industries as opportunity offers.

In other words we have endeavoured to cast over the whole country an economy net, having a large mesh in order that it may be operated quickly, and even if a large percentage of the special industrial fish slip through, the remaining result will be of more direct assistance to the immediate coal situation than if we had waited for a perfect net of small mesh which would produce an ideal haul. As it is, I expect a saving of several million tons. We quite appreciate that to do this work thoroughly, it would be desirable to spend a week at each works, making detailed tests, &c., but it requires very little imagination to visualise what this would mean in time, staff and instruments, &c., if any reasonable amount of ground was to be covered.

Again, we appreciate the difficulty of obtaining new plant at the present time, and whilst we are giving considerable assistance in connection with Priority Certificates, where such are proved to be of direct value to present conditions, our main efforts are for the time being directed to correcting the more simple cases of flagrant inefficiency—they are numbered by the thousand—whilst at the same time taking note of possibilities in other directions, such as re-construction, concentration, plant modifications, &c., for future consideration.

Gentlemen, I am afraid I have wearied you, but I have endeavoured to put my ideas, for what they are worth, plainly before you, and I hope I have said nothing to offend. After all, we all want to deal with facts and avoid camouflage—that hateful word which I hope will soon be out of use and forgotten. I do not feel that I have said anything new, but if I have by chance planted a germ of thought in any direction, I hope that it may develop, and that in spite of the disturbed atmosphere surrounding the whole coal situation, the Controller may find his harvest better than he expected.

Do not wait until the Controller asks you to do certain things—do them on your own initiative.

Do not grumble and criticise the doings of the Coal Controller—Trust the man at the Helm.

The rationing of food must have been a difficult task, but the greater difficulty of coal rationing can only be fully understood by gentlemen like yourselves, who understand the complex nature of coal and its more complex application to the various industries. Think of the colossal task which he has undertaken, and, remembering that in handling such enormous detail it is impossible to avoid some mistakes and certain hardships, do your utmost to help things forward.

German Business Propaganda Abroad.—The committee of the German peace industries, at a recent meeting, discussed the question of business propaganda abroad. It was urged that Germany was being left behind in this matter by her enemies, and it was decided to undertake a very comprehensive business propaganda.

The Ferro-Concrete Shipbuilding Industry in Germany, Italy and Norway.—The first German ferro-concrete shipbuilding company has been formed in Hamburg under the style of Eisenbeton Schiffbau Aktiengesellschaft. The company takes over a small going concern, and its programme comprises the building of ferro-concrete vessels, floating docks, &c. The capital is 1,000,000 marks. The management of the new undertaking rests with a concrete and ferro-concrete company in Neustadt. In Italy a number of ferro-concrete shipbuilding concerns are coming into existence, amongst them one in Genoa, one at Voltri, near Genoa, and two in Naples. In Norway the building of ferro-concrete vessels and lighters goes ahead at a rapid rate and a couple of vessels of 1,000 tons are already afloat. Up to the end of August the Fougner yard had built 24 vessels of different type and size, a floating dock, a lightship, &c.

HARDNESS TESTING.

*Report on Hardness Testing: Relation between Ball Hardness and Scleroscope Hardness.**

By A. F. Shore, New York, U.S.A.

With an Introduction and a Commentary by Sir Robert Hadfield, F.R.S.

Introduction.

It may be remembered that at the May meeting of the Iron and Steel Institute I communicated the substance of a telegram I had received from Mr. Shore dealing with the relation between ball hardness and scleroscope hardness. This telegram, which was transmitted in the hope that it might interest the members present, ran as follows: "Have found apparent true scientific relation of ball and scleroscope the way to measure by ball faithfully up to 800 deg. Exhaustive analysis by both methods, and their relation to a constant depth variable load ball system."

This telegram was the outcome of a number of investigations made during the last few years on the subject of hardness determination, and of correspondence between Mr. Shore and myself. I was at that time investigating hardness tests, particularly in the higher ranges, in the Hadfield Research Laboratory in Sheffield, with the object of finding a satisfactory factor for converting Brinell hardness numbers to scleroscope numbers and *vice versa*. In the course of the correspondence referred to, the following questions were formulated and sent to Mr. Shore from the Hadfield Research Laboratory:—

1. Is it possible to find the relation between ball hardness, commencing with 150 up to 800, and scleroscope degrees? Also for each advance of, say, 50 Brinell hardness numbers, what is the difference in scleroscope numbers, and what is the necessary factor to convert each of these from Brinell into scleroscope numbers, and *vice versa*.

2. Can a special scleroscope be supplied for determining in Brinell numbers instead of scleroscope, or both, highly hardened products ranging from 550 to 750 Brinell ball? The figures now obtained from the present apparatus do not appear altogether reliable. The scleroscope appears not to read to such a fine point as the Brinell.

Mr. Shore's replies having now been received, form the subject of the report which follows.

Report on Hardness Testing.

With the object of throwing a light on the subject of the questions received from Sir Robert Hadfield, the author has undertaken an elaborate series of experiments, the results of which are shown graphically in the accompanying charts I, II and III. A wide variety of metals, with different states of heat-treatment and both ferrous and non-ferrous, were selected. The charts bear on the following aspects of this subject:—

Chart I.—Relation between scleroscope and ball tests from the hardest to the soft metals, using 3,000 kg. throughout under 10-mm. steel ball.

Chart II.—Relation of ball test and scleroscope, using 62 kg., 250 kg., 500 kg. and 750 kg., respectively. Above 325 Brinell or 60 scleroscope, a diamond sphere 10 mm. in diameter was used, because of the flattening of steel ball.

Chart III.—The scleroscope against the number of pounds required to cause a 10-mm. ball impression of 1 mm. in diameter from the softest to the hardest metals. In this instance the depth and diameter of impressions were constant, while the pressure was the variable factor.

Explanation of Chart I.—Curve A. It was not found possible to obtain a satisfactory conversion curve, as its wavy appearance indicates. More than this, the readings were widely scattered. This is probably due to the use of excessive pressures. From approximately 700 Brinell to 550, wide discrepancies are caused by flattening of the ball. From 550 down to about 200 Brinell, abnormally high readings are obtained, due to the superhardening of this series of metals, which is necessarily possessed of marked toughness. Below 250 similar superhardening occurs, but Brinell readings have a tendency to fall below the best average line, because the superhardening is neutralised by flow in the metal. In order that these tendencies may be shown out more clearly, a comparison is given in the dotted line B, B′, D, D′, taken from Chart II.

There is also included a chart by Mr. J. J. Thomas (Fig. 3, page 447), who has endeavoured to establish a relation between the Brinell (using 300 kg.) and scleroscope methods. Curve lines A and B were drawn by him. Curve C, which is irregular, is thought to be a better average, and has been drawn and added by the author. This curve corresponds quite well with curve A, Chart I, and shows the distortions caused by the several conditions named, which are due to use of excessive pressure.

Explanation of Chart II.—Curve B, B′, C, C′, was produced by the pressures indexed in the chart, by the use of a steel ball. It was very difficult to read the impressions on steels above 80 hard scleroscope. It was soon observed that, using a steel ball above 450 Brinell or 85 scleroscope, a pressure of 750 kg. was insufficient. Hence the diamond sphere previously referred to was used. This pressure, and even 500 kg., was now sufficient and enabled the curve B, B′, to be continued up to nearly 800 Brinell, with what the author regards as unusual consistency in its agreement with the scleroscope at the ratio graphically shown.

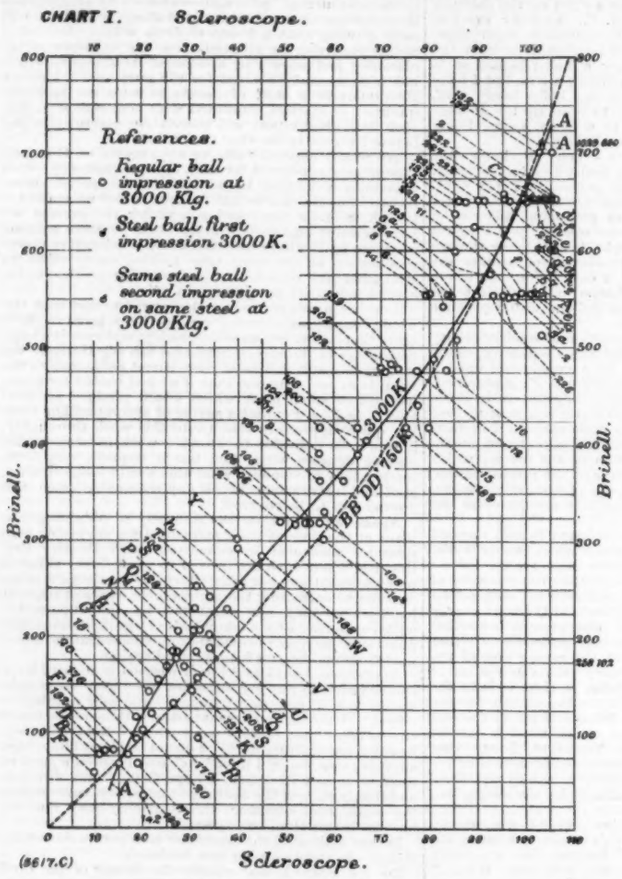
Explanation of Chart III.—In the abscissa of this chart, the scleroscope numbers are used, while in the ordinates the number of pounds required to produce an impression 1 mm. in diameter, using a 10-mm. ball, are used. Curve E and E′, therefore, represents a co-ordination of these values. The constant diameter and variable pressure system has been adopted, because this is theoretically the correct way of measuring absolute hardness under the resistance to penetration principle, and is therefore used as a means of investigating the scleroscope scale. It may just as well be used to investigate the Brinell scale.

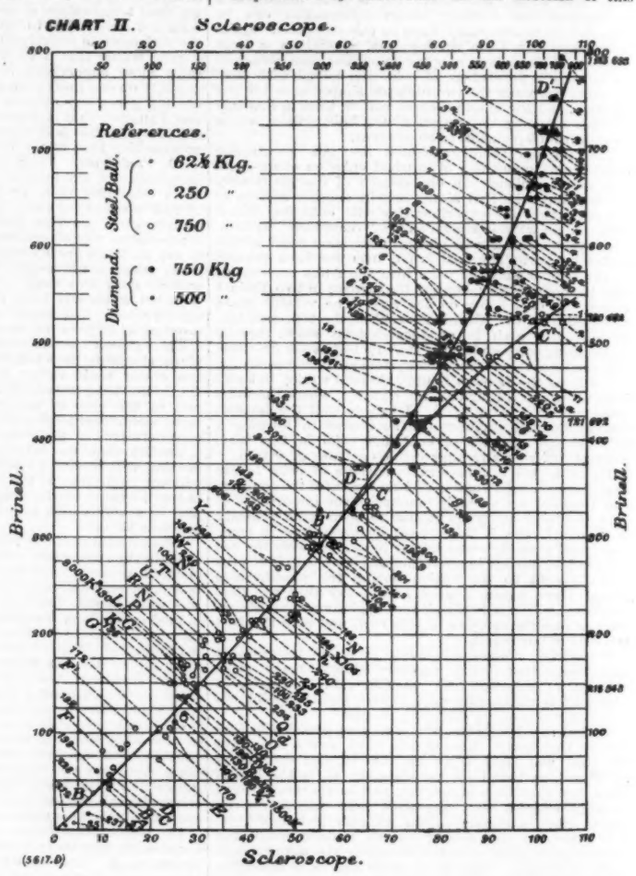
In the past the author contented himself with checking up the Brinell method with the scleroscope and *vice versa*. The time has now come when both methods have been more or less questioned, particularly on the higher ranges of hardness, and hence the importance of curve E, E′, which appears to supply the data necessary.

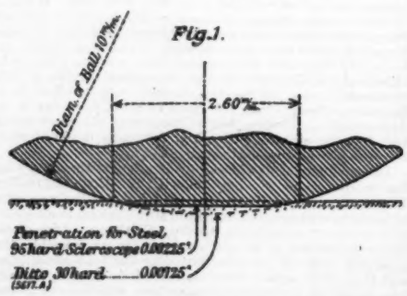
Use of a Steel Ball versus a Diamond Ball.—Quenched carbon steel, 100 hard scleroscope, has a plane surface resistance to indentation of approximately 700,000 lb. per square inch, whereas Brinell pressure at the same hardness, using 3,000 kg., develops practically 1,000,000 lb. per square inch. A steel ball can only sustain this load by flattening out. The result will then be that the penetration will be one-third as much as it will be in annealed carbon steel for the same diameter of impression as per diagram Fig. 1.

Above 85 hard scleroscope there appears to be a kind of adjustment between the steel ball and the sample under test, which has a tendency to cause an indentation having always the same diameter, regardless of a considerable variation of hardness of the said sample as indicated by the scleroscope, or as can be indicated by the Brinell method, using a diamond sphere.

Thinking that the flat on the steel ball which had been caused by previous tests may have been the cause of the lack of discrimination, a series of tests were made on the same block of steel, using each time a new and







* Paper read before the Iron and Steel Institute, September 12, 1918.

round surface, followed by a second test, without changing. In other words, testing with the previously flattened ball, a difference of from 100 to 150 Brinell numbers could be obtained in this way, the flattened ball reading always lower than the unflattened ball. These impressions are illustrated in Chart I. The hardness of the ball used was 105 scleroscope, although the average run, as usually supplied to the trade, is about 100 hard.

As far as the author's experiments have gone, he has been led to the conclusion that by the use of a steel ball no consistent results can be obtained above 85 hard scleroscope. By the use of a diamond, at a pressure of 750 kg., the value of the most intensely hard steel can be ascertained as per his curve B, B′, D, D′. The diamond (yellow) has a resistance of approximately 1,250,000 lb. to 2,000,000 lb. to the square inch, provided, of course, it has been carefully selected and its cleavage planes are at right angles to the plane of the test sample. The highest pressure employed on carbon steel 105 hard in Chart II was 1,125,693 lb., thus showing that it is dangerously close to the limit. While it has thus been shown that the diamond can be used under the Brinell press measuring steel at its highest hardness, it hardly lends itself to commercial application for the following reasons: (1) The indentations made are so small as to be extremely difficult to read even under perfect laboratory conditions. (2) The loss due to breakage of diamonds would almost be prohibitive. In the experiments the regular hydraulic Brinell testing machine was not considered as accurate enough for the use of the diamond under 750 kg. An ordinary beam weighing scale arrangement was substituted. One or two seconds of time was allowed; more time did not materially influence the results.

Relation of Scleroscope to Brinell.—Curve B, B′, D, D′ is regarded as one indicating with as much accuracy as can be reasonably expected the true relation between scleroscope and Brinell methods. It is readily seen that the relation is a sliding one, as indicated in the short heavy black cross marks on the upper part of the chart, in which each division represents 50 deg. Brinell. Assuming that the diamond could be made to stand up better than it does under 750 deg. kg., the pressure curve B, B′, D, D′, would appear to substantiate Sir Robert Hadfield's claim that on the higher hardnesses the Brinell method discriminates more delicately.

When the several conditions which have to be reckoned with, however, are considered, such as: (1) The condition of the surface; (2) errors in measurement, which often approach 75 Brinell numbers on the same piece, carefully and uniformly hardened; (3) the time allowable in commercial practice; (4) the rapid fatigue of the operator, it will be seen that the scleroscope, which regularly uses a diamond, will, after all, discriminate the closest on hard steel.

An advantage of this instrument is that dozens of tests can be made and averaged up on the same sample, agreeing within 2 deg. or 3 deg. of each other.

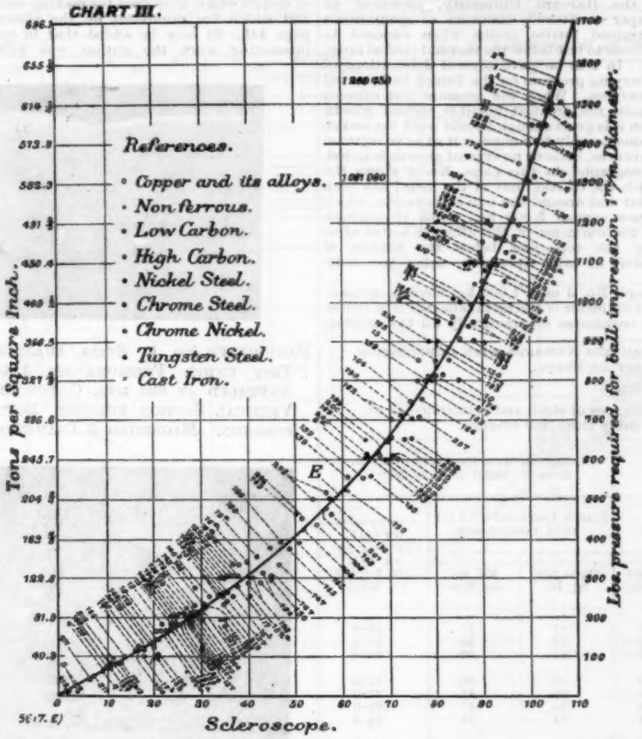
Constant Depth System.—While this provides a very good check for any penetration-measuring machine, and can be used on the hardest steels, it is necessary to use a diamond on hardnesses over 80 scleroscope. This demands that the indentations made shall be very small—not much more than 1 mm. in diameter—and these, as before pointed out, are too small to be read with accuracy in general commercial practice.

While, as before stated, the constant depth variable load system can be readily applied on the harder steels by the use of a diamond, it is particularly advantageous on the softer materials, not only metals, but all substances, even elastic rubber. Hitherto there had been no way of measuring the hardness of organic compounds or materials, because of the peculiar fibrous structure or resilient properties. By this method it is very easy to measure the amount of pressure required to cause a fixed penetration. This will provide a reading which is not influenced in the slightest degree by any peculiar physical property save that of resistance to penetration or hardness. It may therefore be said to lend itself to the testing of hardness on any known substance which is not too brittle.

The Scleroscope provided with a Brinell Scale.—Reference to the accompanying charts will show that it is a very simple matter to provide the scleroscope with a corrected Brinell scale as per curve B, B′, and D, D′, or the constant depth variable pressure curve E, Chart III. As before stated, the relation for each set of degrees is of a sliding character, meaning that on the upper scale the size of the degrees would become less and less. In other words, they would be compressed.

Sir Robert Hadfield's suggestion that the scleroscope may perhaps be used for indicating the hardness with closer discrimination than it had been possible in the past on metals of high hardness was made the subject of an experiment. This consisted of reducing the standard area of the diamond point of the scleroscope, so that where formerly it showed 100 on quenched steel of this hardness, it now only showed 75. It was thought that by this arrangement smaller differences of hardness in these hardened steels would be magnified because of the greater striking force or rebound that would be possible by carrying the present 100 mark down further. While it is true that in this way hardnesses greater

CHART III.



LIST OF METALS AND MATERIALS USED IN THE EXPERIMENTS. (SEE CHARTS I, II AND III.)

A. Aluminium.
B. Brass, cast.
C. Copper, annealed.
D. Brass annealed.
E. Zinc.
F. Copper.
G. Machine steel, soft, $\frac{1}{4}$ × 1½.
H. Machine steel, annealed.
I. Nickel steel.
J. Brass, hard.
K. Chrome tool steel.
L. Nickel steel.
M. Machine steel, CR.
N. Manganese steel, ductile.
O. 1 per cent. carbon steel, unannealed.
P. Manganese steel, brittle.
Q. Manganese bronze.
R. Phosphor bronze.
S. High-speed steel, annealed.
T. High speed steel, annealed, No. 100.
U. Vanadium steel.
V. Projectile steel, annealed.
W. 2 per cent. carbon steel.
X. High-speed steel, compressed, $\frac{1}{16}$ × 1½.
Y. Chrome nickel steel, $\frac{1}{16}$ × 1½.
Z. 1·65 per cent. carbon steel, $\frac{1}{8}$ × 1.
a. Tool steel, No. 106.
b. Tool steel, drawn, 1in. × 3 in. bat.
c. High-speed steel, drawn at 1,400 deg. F., No. 104.
d. Cast-iron.
e. Tool steel, No. 103.
f. Tool steel, No. 102.
g. 6 per cent. nickel steel.
m. Bessemer steel rod.
h.
1. 1½ in. square 1·10 carbon steel.
2. 1½ in. square 1·10 carbon steel, full hard.
2A. 1½ in. square 1·10 carbon steel, full hard.
2B. 1½ in. square 1·10 carbon steel, on end.
3. Tin.
3A. High-speed steel gear.
4. Bethlehem projectile steel, full hard.
4. Aluminium plate, annealed.
5. Bethlehem projectile steel, drawn at 480 deg. F.
6. Chrome nickel steel.
6A. Bethlehem projectile steel, drawn at 800 deg. F.
7. High-speed steel block.
8. $\frac{3}{4}$ in. × $\frac{3}{4}$ in. high-speed steel bar.
9. $\frac{1}{2}$ in. × $\frac{1}{2}$ in. high speed steel.
10. $\frac{1}{2}$ in. × $\frac{1}{2}$ in. high-speed steel.
11. Bethlehem projectile steel, full hard.
12. Chrome nickel steel gear.
13. Chrome nickel steel bevelled gear.
14. Chrome nickel steel bevelled gear.
14–2. Chrome nickel steel, softer hub.
15. 1 in. × 1 in. 1·25 carbon steel, tempered.
16. Drill rod, annealed.
16A. Drill rod, cold-rolled.
16B. Drill rod, unannealed.
17. Mild steel, $\frac{1}{2}$ in. × $\frac{1}{2}$ in.
17A. Mild steel, $\frac{1}{2}$ in. × $\frac{1}{2}$ in., cold-rolled.
17B. Mild steel, $\frac{1}{2}$ in. × $\frac{1}{2}$ in., annealed.
18. Mild steel, $\frac{1}{2}$ in. square.
18A. Mild steel, $\frac{1}{2}$ in. square, cold-rolled.
19. Mild steel, $\frac{1}{16}$ in. × 1 in.
19A. Mild steel, $\frac{1}{16}$ in. × 1 in., cold-rolled.
20. Mild steel, 1 in. × $\frac{1}{2}$ in.
20A. Mild steel, 1 in. × $\frac{1}{2}$ in., cold-rolled.
100. High-speed steel.
101. Projectile steel, annealed.
102. 1·25 carbon steel, 1 in. square.
103. 1·25 carbon steel, 1 in. square, drawn.
106. 1·25 carbon steel, 1 in.
108. 1·25 carbon steel, 1 in., drawn.
125. High-speed steel, $\frac{1}{2}$ in. × 1 in.
126. Chemically pure iron.
127. 12·5 carbon steel, 1 in. square.
128. 12·5 carbon steel, 1 in. square.
129. 12·5 carbon steel, 1 in. square.
130. 12·5 carbon steel, 1 in. square.
131. 1·52 carbon steel, 1 in. square.
132. 1·52 carbon steel, 1 in. square.
133. High-speed steel, $\frac{1}{2}$ in. × 1 in.
134. High-speed steel, $\frac{1}{2}$ in. × 1 in.
134A. 1·25 carbon steel, 1 in. × 1 in.
135. 1·25 carbon steel, 1 in. × 1 in.
136. 1·25 carbon steel, 1 in. × 1 in.
137. Cast-iron.
138. 4-in. ball bearing.
139. 1·25 carbon steel, drawn, 500 deg. F.
140. $\frac{1}{2}$-in. plate, brass.
140A. Manganese steel, ductile.
140B. Manganese steel, brittle.
141. Cast-iron, $\frac{1}{2}$ in. × $\frac{1}{2}$ in.
142. Manganese bronze bar.
142. Zinc, 1-in. bar.
143. Commercial nickel steel.
144. Machine steel, cold-rolled.
145. Machine steel, cold-rolled.
146. Machine steel, cold-rolled, annealed.
146. Machine steel, cold-rolled.
147. 1 per cent. carbon steel, unannealed.
148. Nickel steel, annealed.
149. Chrome nickel steel, annealed.
150. 2 per cent. carbon steel.
151. Steel casting.
152. Annealed high-speed steel, compressed.
152A. Annealed high-speed steel, compressed.
153 Vanadium steel.
154. Phosphor-bronze bar.
154A. Phosphor-bronze bar.
155. Phosphor-bronze casting.
156. Brass, cast.
157. Aluminium, hard.
158. Copper, hard.
159. Copper, soft.
160. Carbon steel, tempered, $\frac{1}{2}$ in. × 2 in.
161. Carbon steel, tempered, 1 in. × 1 in.
162. Carbon steel, tempered, 1 in. × 1 in.
163. Carbon steel, tempered, 1 in. × 1 in.
164. Carbon steel, tempered, 1 in. × 1 in.
165. Carbon steel, tempered, 1 in. × 1 in.
166. Hard copper.
167. Hard brass.
168. Aluminium.
169. Bar brass on end.
170. Bar brass on end.
171. Bar brass, annealed.
172. Mild steel, hot-rolled.
173. Stellite.
174. Drill rod tension test-piece.
175. 1 per cent. carbon steel, 1 in. diameter.
176. 1 per cent. carbon steel, 1 in. diameter.
177. 1 in. drill rod on end.
178. High silicon spring steel.
179. Chrome steel, drawn, 480 deg. F.
180. Watch-case die carbon steel.
181. $\frac{1}{8}$ in. cold-rolled steel.
182. 1·65 carbon steel, overheated.
183. 1·65 carbon steel, slightly overheated.
184. 1·65 carbon steel, unannealed, quenched below critica point.
185. 1·25 carbon steel, 1 in. × 1 in., drawn.
185A. 1·25 carbon steel, 1 in. × 1 in., drawn.
185B. 1·25 carbon steel, 1 in. × 1 in., drawn.
186. 1·25 carbon steel, 1 in. × 1 in., drawn.
188. 1·65 carbon steel, $\frac{1}{2}$ in. × 1 in., drawn.
189. 6 per cent. nickel steel.
190. $\frac{1}{2}$ in. × $\frac{1}{2}$ in. square high-speed steel.
191. Chrome steel, annealed.
194. Manganese steel, ductile.
195. Chrome nickel steel.
196. Nickel steel, annealed.
197. 6 per cent. nickel steel.
198. 2 per cent. carbon steel.
199. $\frac{1}{2}$-in. plate, copper.
200. Chrome nickel steel, $\frac{1}{2}$ in. × $\frac{1}{2}$ in.
201. Vanadium steel, $\frac{1}{2}$ in. × $\frac{1}{2}$ in.
202. 3½ per cent. nickel steel.
203. Steel casting.
205. Silicon spring steel.
206. Silicon spring steel.
207. Vanadium steel.
208. Semi-high-speed steel.
209. High-speed steel inserted milling cutter blades.
210. High-speed steel inserted milling cutter blades.
211. Copper, $\frac{1}{2}$ in. × $\frac{1}{2}$ in.
212. Lead.
213. Brass, annealed, $\frac{1}{2}$ in. × $\frac{1}{2}$ in.
214. $\frac{1}{2}$-in. brass bar.
215. Chrome nickel.
216. Carbon, 1·75; tungsten, 1·75.
217. Nickel steel.
218. 62 per cent. carbon.
219. 1·25 carbon, annealed.
220. Carbon, 1 per cent.; chrome, 1 per cent.
221. 1 in. × 1 in. 1·25 carbon steel.
222. $\frac{1}{2}$ in. square high-speed steel.
223. 1·34 carbon steel, 2 in. × 2 in.
224. 1·24 carbon steel, 2 in. × 2 in.
225. 1·75 carbon steel, tungsten.
226. High carbon chrome nickel steel.
227. High carbon chrome nickel steel.
228. Aluminium plate.
229. Carburised chrome nickel steel.
230. Vanadium steel, $\frac{1}{2}$ in. × 1 in.
231. Tin lead alloy.
233. Cast-iron.
234. Cast-iron.
235. Cast-iron.
236. Cast-iron.
237. 1·25 carbon steel.
238. 1·25 carbon steel.
239. 1·25 carbon steel.
240. 1·65 carbon steel, $\frac{1}{2}$ in. × 1 in., overheated.
241. Vanadium steel, $\frac{1}{2}$ in. × 1 in., tempered.
242. Carburised chrome nickel.
243. Projectile steel chrome nickel, tempered.

than is now found in steel can be measured, nothing was gained, and there was no closer discrimination, in fact not so close, for the reason that the hardness degrees were 25 per cent. smaller on the whole scale.

Relative Hardnesses.—The hardness of lead compared with that of steel 100 hard scleroscope in terms of pounds required to cause a standard ball impression of 260 to 1 is by the Brinell method 145 to 1. By the scleroscope standard scale, taking 100 hard as the average for quenched steels, the relation is 50 to 1. This shows that neither of these two instruments gives the true relative hardness. This, however, while important to know, is of little importance in general practice for the reason that each scale may now readily be converted into the other.

Influence of Pressure on Ball.—The several tables of figures given by Sir Robert Hadfield as representing progress made, showing the relation of Brinell using a pressure of 3,000 kg. and that of the standard scleroscope, vary considerably, as will be seen by comparison with one another. They also are not in perfect agreement with the results obtained by the author and hereby submitted, using both 3,000 kg. and 750 kg. The study of Chart II will disclose that a curve resembling that of E, Chart III (closest), is obtained by the use of a lower pressure. The curve is gradual, consistent, and, in the author's estimation, scientific. It will be noted here that on hardened steels both 700 kg. and 750 kg. have been used. This did not materially influence the

Carbon Steel Hardened.

Scleroscope 943,000 lb. per square inch, hardness 100.
Ball test (10 mm. diameter, using diamond):
750 kg., 995,000 lb. per square inch, hardness 680.

At the Sixth Congress Internal Association for Testing Materials, held in New York, 1912, Professor Albert Sauveur, of the Harvard University, presented an interesting paper on Stead's discovery of spontaneous growth of strained ferrite grains when exposed to temperatures close to but below the thermal critical range of the metal. In this he gave several illustrations of the effect of varying pressure on the Brinell ball as used for testing hardness. When the pressure just exceeds the elastic limit, the greatest possible crystal growth occurs. When it is great enough to cold work the metal, however, or considerably to compress it so as to increase its original hardness, little or no crystal growth is noted.

In the photographs on this page, No. 1 shows the extent to which the elastic limit of the metal has been overcome under and around the ball indentation, which in this instance carried 3,000 kg., while photograph No. 2 shows the diameter of the affected metal after cutting away the top, just below the bottom of the indentation in same specimen, using the same pressure.

In photograph No. 3 only 1,000 kg. have been used. The depth and diameter of the metal affected is of course less, but the coarseness of practically all the crystals

TABLE I.—Comparison of Brinell Ball and Scleroscope Hardness Numbers with Compression Strength, also Yield Point and Tenacity of Steel.

Prepared by Sir Robert Hadfield.

This table represents the average of a large number of tests on all types of steel, and is intended as an approximate guide. Individual results vary considerably from the average.

Zones of Hardness F to A.	Approximate Scleroscope Hardness Number.	Brinell Ball Hardness Number.	Tensile Strength.				Compression on Specimens 0·564 in. diameter and 0·70 in. in height.		
			Yield-Point.		Maximum Stress.		Elastic Limit and 0·25 per Cent. Compression.		Compression per Cent. (100 Tons per Sq. In.). (160 Kg. per Sq. Mm.).
			Tons per Sq. In.	Kg. per Sq. Mm.	Tons per Sq. In.	Kg. per Sq. Mm.	Tons per Sq. In.	Kg. per Sq. Mm.	
F	—	150	20	31	36	57	17	27	49·0
	—	175	26	41	41	65	19	30	40·0
	34	200	32	50	46	72	21	32	35·0
E	38	225	38	60	51	80	23	36	31·0
	42	250	44	69	56	88	26	41	27·0
	46	275	50	79	61	96	30	47	23·0
	50	300	56	88	66	104	34	54	19·0
D	54	325	61	96	71	112	38	60	15·2
	57	350	67	105	76	120	43	68	11·3
	61	375	73	115	81	128	49	77	8·0
	64	400	79	124	86	135	55	87	5·6
C	68	425	84	132	91	143	61	96	3·8
	71	450	90	142	96	151	67	105	2·4
	75	475	96	151	101	159	74	116	1·3
	78	500	102	161	106	167	81	127	0·6
B	80	525	107	169	111	175	87	137	0·23
	84	550	113	178	116	183	94	148	0·21
	86	575	—	—	121	190	101	159	0·20
	89	600	—	—	126	198	108	170	0·18
A	92	625*	Not determined		131	206	115	181	0·16
	95	650			136	214	122	192	0·14
	99	675			141	222	129	203	0·13
	101	700			—	—	136	214	0·12
A2†	—	725	Not determined		Not determined		144	227	0·11
	—	750					151	238	0·09
	—	785					159	250	0·08
	—	800					166	261	0·07

* Glass scratching hardness commences here.
† Owing to want of data, but little is known about this extremely high zone of "superhardness."

results obtained, and if anything the 5,000-kg. readings are closer in agreement to the scleroscope than the 750-kg. ones.

On the soft metals there appears to be convincing evidence that the hardness readings are influenced by the amount of pressure put on the ball. At the Fifth Congress of the International Association for Testing Materials at Copenhagen, 1909, Dr. P. Ludwik, of Vienna, discussed this phase of the question. He recognised the varying amount of flow phenomena and of cold working due to pressure which changes the original hardness of the material so that a particular metal will show different readings dependent upon the amount of pressure upon the ball.

In a specimen of annealed carbon steel (28 hard scleroscope) that we have investigated, we have found the following: E.L. resistance to compression of a cylinder ½ in. in diameter, 75,000 lb. per square inch; tension, 42,000 lb. per square inch; the same steel under a flat punch on its plane surface offers a resistance of 102,000 lb. per square inch—that is to say, this is the point at which it begins to take visible permanent set.

The following are the pressures exerted by the scleroscope and ball tests, the latter using a series of different pressures on the soft metal:—

Scleroscope, 160,000 lb. per square inch, hardness 28.
Ball test (10 mm. diameter):
500 kg., 170,000 lb. per square inch, hardness 120.
750 kg., 216,000 lb. per square inch, hardness 150.
1,000 kg., 231,630 lb. per square inch, hardness 159.
3,000 kg., 258,000 lb. per square inch, hardness 170.
4,500 kg., 277,000 lb. per square inch, hardness 182.

indicates that the pressure used was little more than enough to overcome the elastic limit.

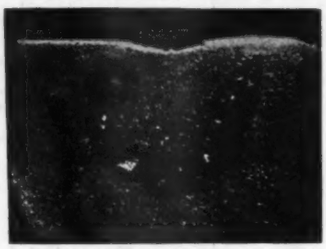
Hardness and Elastic Limit.—It has been the author's claim from the outset that the scleroscope, which uses comparatively light pressures—just enough to overcome the elastic limit automatically regulating its impact pressure—measures a value closely associated with the elastic limit. For the Brinell test, on the other hand, it has been claimed that by the use of the ball method a symbol which leans toward, and in fact which measures, the ultimate strength is given.

Here it would appear obvious that two methods which tend in opposite directions cannot be expected to agree as well as if they both tended in the same direction, as toward the elastic limit. In view of this fact, it would appear obvious that if a scientific relation between the ball and scleroscope tests were established, the tendency toward the ultimate strength would have to be eliminated and the tendency towards the elastic limit would have to be adopted. This would mean that the ball test must not use much more pressure per square inch than is exerted by the scleroscope.

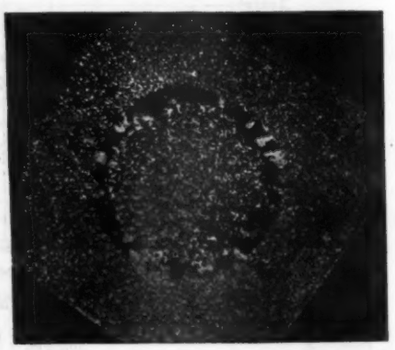
The author regards 1,000 kg. on a 10-mm. ball as certainly the limit. 750 kg. is perhaps much nearer to being scientifically correct, that is, if the ball test is to be made to agree in a definite manner with the scleroscope or the constant depth scale, Chart III. He regards 3,000 kg. as absolutely excessive, as the table of figures alongside shows. If the ultimate strength is to be investigated without attempting to find a satisfactory relation to the scleroscope scale, a pressure of 3,000 kg. may be used.

Whether this would be too low or excessive would appear to be determined by that which is necessary to cause the limit of hardening by cold working. Reference to Chart I shows that there is a decided drop in the curve at 20 to 25 hard scleroscope, which would appear to indicate that 3,000 kg. for investigating ultimate strength is excessive, in that flow occurs without further mechanical hardening.

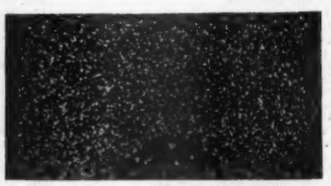
Test Samples Used.—A complete list of the series of metals which were used for making comparative tests, and which are numbered on the charts, is given on page 445. It may be added that in carrying on this interesting work the author was ably assisted by



Photograph No. 1. Steel, subjected to Ball Test under Pressure of 3,000 kg. and Annealed at 650 deg. C. for Seven Hours. Vertical Section through Bottom of Depression. Magnified 6 Diameters.



Photograph No. 2. Same Steel Tested and Treated as Indicated under Photograph 2. Horizontal Section through Bottom of Depression. Magnified 6 Diameters.



Photograph No. 3. Same Steel, Subjected to Ball Test under a Pressure of 1,000 kg. and Annealed at 650 deg. C. for Seven Hours. Vertical Section through Bottom of Depression. Magnified 6 Diameters. Reduced by One Quarter.

Mr. F. G. Kendall, of Pittsburg, and by his brother, Mr. Charles P. Shore, who selected and prepared the diamonds; also most of the test samples.

Commentary by Sir Robert Hadfield.

1. Briefly, Mr. Shore's statements appear to indicate the following:—

2. Chart I shows the statements he puts forward with regard to correlating scleroscope and Brinell tests, the latter carried out under the ordinary conditions, that is, with 3,000 kg. pressure. He shows that there is no very definite relation on these lines, which, of course, is in line with our and other people's experience.

3. Looking further into the matter, he sees that the trouble lies in the way the Brinell test is usually carried out, that is, using a standard pressure of 3,000 kg., and obtaining a different size of impression for different materials. This is fundamentally wrong, and instead the Brinell method should be so used as to obtain the same size of impression on every material, no matter what the hardness (the pressure required to do this is then the measure of the hardness).

4. Of course this is still inside Brinell's definition, but another and better way of carrying out the test. The

reason why this gives a better indication of the Brinell hardness is that each specimen is deformed to the same extent. Consequently the effect of deformation hardness is the same for all.

5. Mr. Shore argues also that his scleroscope test does not much exceed the elastic limit of the material, and, therefore, is a guide more particularly to the elastic limit, whereas the ordinary Brinell test much exceeds the elastic limit, and, therefore, is more of a guide to the tenacity, so that the scleroscope and ordinary Brinell tests cannot be expected to correlate very closely.

6. By reducing the pressure in the Brinell test so as not to exceed the elastic limit appreciably, better correlation should be expected between the two methods. His arguments are fully justified by Chart III, where he has got a very good relation between the two on a very wide range of materials.

7. As comment on the above, it has, of course, to be recognised that Brinell tests are commonly carried out with 3,000 kg. pressure, and therefore Chart I, imperfect as it is, is really the best chart for comparing scleroscope and Brinell.

8. Chart III shows how scleroscope and Brinell compare when the Brinell test is carried out on ideal lines. It is to be feared, therefore, that it is, at the moment, only of academic interest, though it makes out a strong case for revising the method of carrying out the Brinell test; but as Mr. Shore points out, the use of small pressures means impractical impressions. No doubt the difficulty of producing a definite size of impression on any specimen, whatever the hardness, could be got over by refinement of the apparatus. Certainly by revising the Brinell methods on these lines we should get a hardness figure which represents something more definite as to the hardness than the present method gives. As Mr. Shore points out, a different hardness figure is obtained when using 1,000 kg. pressure to that when using 3,000 kg. pressure, due to the larger amount of deformation in the latter case.

9. Quite a separate point is the use of a diamond ball. This is certainly very interesting indeed, and from Mr. Shore's results gets over the difficulty of the deformation of steel balls when testing hard specimens (see Chart II). Unfortunately, diamond will not stand more than about 750 kg. pressure, so that it is not a very practical material, but it has enabled him to prove the point definitely that fictitious hardness figures are obtained on hard specimens due to the deformation of the steel ball, which, of course, we have always suspected. Notwithstanding its limitations, the use of this diamond ball helps considerably in the direction of obtaining the true hardness of hardened steel, and in this respect it is the best device hitherto put forward in competition for the Hadfield prize.*

10. It may be added as regards the method of using the Brinell test with a standard indentation instead of a standard pressure, that this point has been well realised in the Hadfield Research Laboratory work; in fact it has the additional advantage that if the diameter of the impression is kept in a definite relation to the diameter of the ball, good comparison is obtained between tests made with different sizes of ball. The difficulty is in applying this principle to practical tests in the works, and having applied it, it would mean that a different hardness figure from the present one would in many cases be obtained. If the present figures are obtained in what is scientifically a wrong manner, they ought to be discarded in favour of more rational figures. If Mr. Shore can devise a practical Brinell testing apparatus which embodies this principle, that is, makes a definite size of impression on specimens of all grades of hardness, it would usefully supersede present methods. If these are wrong they are nevertheless well established all over the world, and cannot, therefore, be dislodged in a hurry.

Fig. 2.

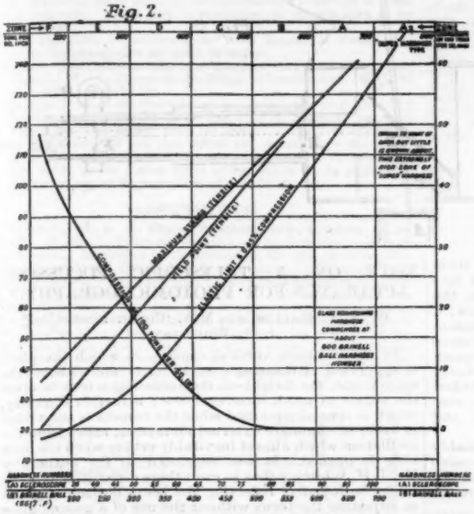
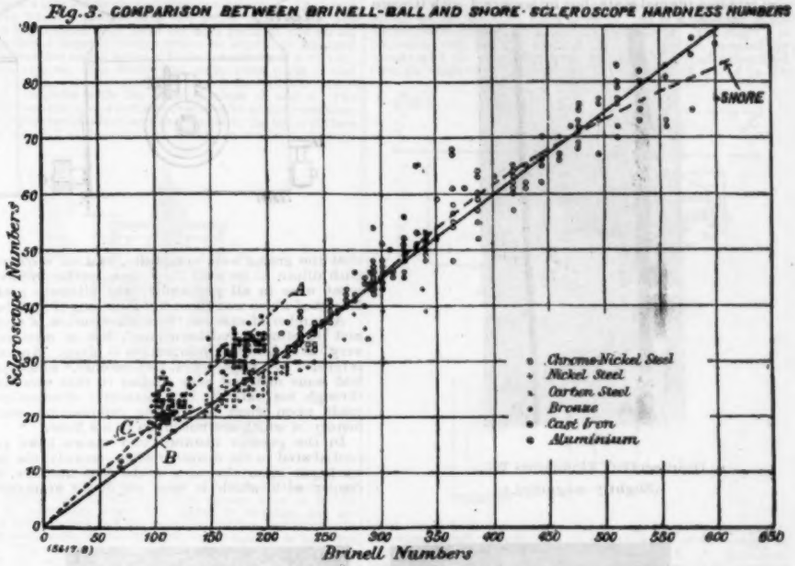


Diagram showing comparison of Brinell Ball and Scleroscope Hardness Numbers with Compression Strength, also Yield Point and Tenacity of Steel, varying from the softest to the hardest "super" hardness types. (This diagram has been prepared by Sir Robert Hadfield from the data of Table I.)

Fig. 3. COMPARISON BETWEEN BRINELL-BALL AND SHORE-SCLEROSCOPE HARDNESS NUMBERS



Zone.	Brinell Ball Hardness Number.		Scleroscope Hardness Number.		Yield-Point. Tons per Sq. In.		Maximum Stress. Tons per Sq. In.	
	From	To	From	To	From	To	From	To
F	150	200	34	34	20	32	36	46
E	200	300	50	50	32	56	46	66
D	300	400	64	64	56	79	66	86
C	400	500	78	78	79	102	86	106
B	500	600	89	89	102	Not determined	106	126
A	600	700	—	101	Not determined	Not determined	126	Not determined

It was found on plotting the values for cast-iron and bronzes that all points were above this line. The broken line shown was therefore plotted, giving a factor of 5·25 for these metals. The three points for aluminium lie between these two lines, giving a factor of about 6. The points for nickel steel lie below the full line, and for these the factor 7·7 seems more suitable.

From the above it is seen that the factor is not constant, but varies with the different metals. In fact, considerable variation is found even in the same metal. The scleroscope readings vary more than the ball tests, probably owing to the fact that the scleroscope measures the hardness of very small areas, and these areas vary in hardness even in the same metal.

It has been found that for hardness numbers above 300 Brinell or 45 scleroscope, metals are very difficult to machine. Tempered steels lie in the range of 150 to 300 Brinell.

No attempt has been made to compare the accuracy or usefulness of the two instruments, as it is believed that each has a place in the testing of materials.

The capital letters in the zone column in the table on this page refer to special sections of zones of hardness.

* Sir Robert Hadfield recently placed in the hands of the Institution of Mechanical Engineers the sum of 200*l.*, which with any income therefrom may be awarded at the discretion of the council of the Institution as a prize, or as prizes, for the description of a new and accurate method of determining the hardness of metals, especially of metals of a high degree of hardness. The award or awards will be made by the Council of the Institution of Mechanical Engineers, whose decision will be in all cases final. The council will consider annually all communications received, and may then award a prize or prizes, but in January, 1922, the offer of prizes will be withdrawn, and any unexpended balance of the prize fund will be diverted to any other purposes to be determined at the discretion of the council.

Hardness Tests: Relation between Brinell Ball Test and Scleroscope Readings.

By J. J. Thomas, Watertown Arsenal, U.S.A.

A number of inquiries have recently reached Watertown Arsenal as to the proper factor to convert Brinell ball-test hardness numbers to scleroscope readings. Many manufacturers and laboratories have one of these instruments, but few have both. In order, therefore, to compare the hardness of their product with that of another factory or to interpret the results given in various papers and journals, it is necessary that the factor connecting the two be known.

The curves shown in Fig. 2, above, were plotted after taking over 500 readings. All Brinell impressions were made with an "Alpha" machine having a steel ball 10 mm. in diameter, with a pressure of 3,000 kg. for 30 seconds. The scleroscope readings were taken with a Shore instrument, having a diamond-tipped hammer.

Different metals have been given different symbols in order that the relative hardness may be quickly noted. The full line gives the relation for steels, and is believed to be a representative curve. For this line the factor is 6·67, that is, the scleroscope reading multiplied by 6·67 gives the Brinell ball hardness numbers.

Analysis of Air from a Mine Fire.—Though some mine fires have been located and watched by the aid of gas analyses, there are very few data of such occurrences. The particulars given by A. G. Blakeley and H. H. Geist in *The Journal of Industrial and Engineering Chemistry*, 1918, pages 552 to 553, will therefore be of interest; the writers are connected with the Philadelphia and Reading Coal and Iron Company, of Pittsville, but they do not specify the mine which is described as being gaseous. On November 18, 1916, several men were overcome while at work in the mine; on November 19 a fire was discovered, and "batteries" were erected to cut off the air supply and to smother the fire. Pipes were extended through these batteries and closed at their outer ends by valves, which were opened from time to time to take samples of the atmosphere within the fire zone. The observations continued from December 1, 1916, to July 26, 1917; the fire zone was partly reopened in August, 1917. The analysis showed that the oxygen percentage in the fire zone decreased slowly, from 18 per cent. on December 1 to 16·4 per cent. on December 5, to 14 per cent. by the middle of January, to 10 per cent. by the end of May, and to 6·4 per cent. and finally 4·8 per cent. in July. There was very little change in the oxygen contents all through the three months, January to March, and the figures, like the others, suggest that the access of air and the gas circulation were not completely stopped; but there are no comments on the figures given. The percentage of carbon dioxide rose slowly and irregularly; there was first a rise from 0·99 per cent. to 2·1 per cent. by January 18; throughout the following months the percentage was about 2·5, with a minimum of 1·6 per cent. on April 5, however, and a maximum of 3·04 per cent. in February; in June the percentage was above 3, and by July 26 it reached its maximum value of 4·47 per cent. The carbon monoxide percentage was very small throughout; it started with 0·008, had its maximum of 0·01 on January 5, decreased then, and after the end of March the presence of CO could no longer be traced. The methane percentage increased from 2·4 to 10·9 finally; the final rise set in in June, but there were fluctuations. These figures all refer to samples taken at one spot; very similar values were found at another spot, also on the same seventh level of the mine. Figures are also given as to the carbon dioxide in the "black damp," but it is not explained how these figures were arrived at; this percentage started with the value 8·28, the maximum of 9·2 per cent. was recorded on February 22, and the end value 6·7 per cent., probably represents the average.

A CASE OF DISINTEGRATION OF A COPPER-ALUMINIUM ALLOY.*

By Richard Seligman, Ph.Nat.D., Member, and Percy Williams, Member (London).

A large consignment of scrap aluminium wire netting was recently received for remelting. The bulk of this wire was in a normal state, but interspersed with it were a number of wire frames which showed unusual signs of disintegration. The surface of the wire (Fig. 1, A, above) seemed to have broken up into a number of loosely adhering grains up to 10 mm. in length uniformly inclined to the axis of the wire. On removing the loose grains a solid core of wire was disclosed (Fig. 1, B) which was found by analysis to contain :—

	Per cent.
Silicon	0.33
Iron	0.30
Copper	2.65 (2.66)

It is considered that this may be taken to have been the composition of the original wire. A sample of the other wire which had not suffered disintegration gave the following figures, which are believed to be substantially representative :—

	Per cent.
Silicon	0.24
Iron	0.22
Copper	0.07

The wire had been used for a number of years solely for supporting thin slabs of gelatine which are said to be free from all chemicals, with the exception of small quantities of hydrogen peroxide, and both the disintegrated and the unchanged wires had been used for the same purpose and for about the same time. The disintegrated wire had apparently been very severely overdrawn, the core breaking readily when bent at right angles. On annealing the ductility of the core was restored, showing that its brittleness was not due to disintegration. The unchanged wire was soft.

The grains were coated with a grey substance, presumably alumina, but when washed with concentrated nitric acid the coating was largely removed and the metallic surface of the grains was exposed. Under magnification of 30 diameters (Fig. 2, above), it was evident that the grains were composite, and on warming them with dilute nitric acid they were further resolved into what were in all probability the ultimate grains, the largest of which was about 0.1 mm. long (Fig. 3, below).

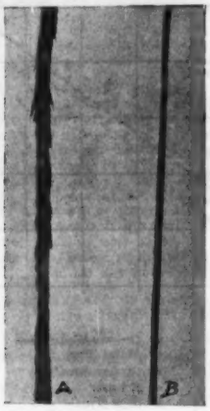


Fig. 1.
Disintegrated Aluminium Wire.
(Slightly magnified.)

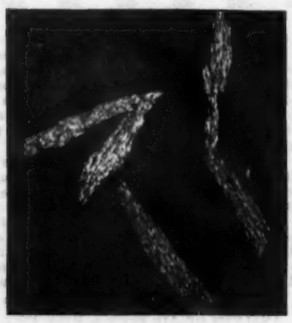


Fig. 2.
Disintegrated Aluminium Wire.
Large grains.
× 30

Fig. 3.
Disintegrated Aluminium Wire.
Small grains.
× 30

Reduced by one-third.

A number of cases of the disintegration of aluminium and its alloys have been cited, but in most instances very little detailed information is given. An exception is formed by a paper by H. Le Chatelier,* who apparently had some material very similar to that now described through his hands. Le Chatelier's observations were made upon sheet metal, the composition, state, and history of which are not given in his Note.

In the present instance two causes have probably contributed to the disintegration—namely, the excessive work put upon the wire in the first instance, and the copper with which it was, no doubt unintentionally, alloyed. In this connection it is not without interest to refer to a statement of Carpenter and Edwards in the "Eighth Report of the Alloys Research Committee of the Institution of Mechanical Engineers," p. 254. Describing a slowly-cooled alloy of aluminium with 4.97 per cent. of copper, Carpenter and Edwards suggest that it consists of crystals which are probably nearly pure aluminium around which the copper-aluminium eutectic is distributed as a cement. If this suggestion were correct the cause of the form which the disintegration had taken in the case under discussion might be found in the dissolution of this eutectic, leaving the crystals or grains unattacked. The grains should then differ in composition from the unchanged wire, and would, if Carpenter and Edwards' hypothesis were fully correct, be found to be free from copper.

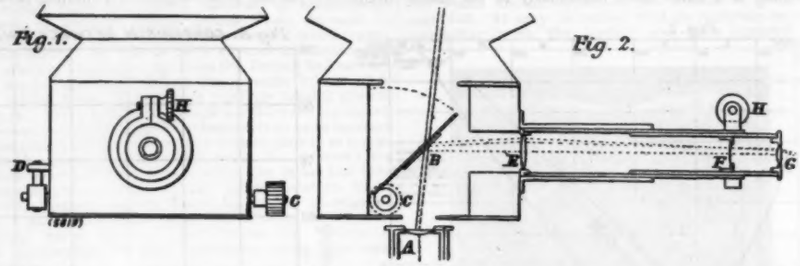
By analysis it was possible to establish the fact that there was a very definite difference between the copper content of the grains which had been warmed with dilute nitric acid and of the unchanged core, but that the grains were far from being pure aluminium. The copper content of the grains was found to be 2.49 per cent. (2.48 per cent., 2.49 per cent.), and that of the core of unaltered wire 2.65 per cent. (2.66).

The writers wish to express their thanks to Professor Carpenter and Miss Elam for their kindness in having the photographs that are used to illustrate this Note prepared.

* Note submitted to the Institute of Metals, Wednesday, September 11, 1918.

* *Revue de Métallurgie*, viii. 373 (1911).

TELESCOPIC FOCUSSING APPARATUS FOR PHOTOMICROGRAPHY.



NOTE ON A TELESCOPIC FOCUSSING APPARATUS FOR PHOTOMICROGRAPHY.*

By A. F. Hallimond, M.A. (Communicated by J. H. Whiteley).

In the ordinary vertical camera, in which the plate is supported at a distance of 10 in. or more above the microscope, the height of the focussing screen is often the source of much inconvenience; a further difficulty, which is specially marked when the camera is suspended in order to eliminate external vibrations, arises from the oscillation which almost inevitably occurs when the dark slide is opened. It was suggested to the author by Mr. J. H. Whiteley that to meet these difficulties a means might be found of reflecting the beam horizontally and so adjusting the focus without the use of a ground-glass in the usual position. The telescopic arrangement here described was designed for this purpose, and resembles the ordinary form of reflex focussing camera. A similar device has been adopted in the Le Chatelier microscope and camera, but, in spite of its convenience, does not appear to be very generally known in this country.

The construction of the apparatus (which might be attached to the front of any camera) is shown in the drawings above; the broken lines indicate the path of a beam which converges to form a point in the image.

Rays proceeding from the microscope eyepiece A, which would normally converge to a focus on the photographic plate, are reflected horizontally by the movable mirror B; this mirror is attached to a metal plate large enough to cut off all light from the camera when in the position shown, and is prevented from passing beyond the 45-deg. position by an adjustable stop D attached to the spindle. The deflected beam is focussed by the telescope objective E (focal length 4 in.) upon the cross-wires F, and the image so formed is seen, together with the cross-wires, when examined through the eye-lens G (focal length ¾ in.). The magnification thus obtained is about the same as that given by the use of a hand-focussing lens upon (or without) the ground-glass.

It will be seen that to each length of camera there corresponds a fixed position of the focus at F, to which the cross-wires must be set by pushing in the sliding tube and closing the clamp H. It is convenient to graduate the sliding tube, by direct comparison with the ground-glass, in numbers representing the corresponding camera lengths. When this graduation has once been made, it is sufficient, in taking a photograph, to fix the telescope for the proper camera length and focus the microscope so that the image is clearly defined on the cross-wires. As soon as the focus is ascertained to be steady and satisfactory, the dark slide having been opened before focussing, the exposure can be made by simply turning back the milled head C, so that the mirror moves into the vertical position.

The lenses described are of the simplest type, and have proved quite satisfactory in working; the field is, however, rather narrow, about one-third of the diameter photographed being visible at once. Mr. Swift, by whose firm the apparatus was made, has suggested that the eyepiece of the telescope might be provided with a field lens, and no doubt the full field could thus be obtained: at the same time it would certainly be well to make the objective achromatic. No difficulty has been found to arise from the use of the mirror, which is a common plane "galvanometer mirror," though the best result would no doubt be given by a silvered right-angled prism. For ordinary purposes the simple form described has proved sufficient and represents a considerable saving of expense in comparison with the more correct construction.

* Paper taken as read before the Iron and Steel Institute, September 13, 1918.

Grain Elevators for South Africa.—The report now issued by the General Manager of Railways and Harbours (Pretoria, Government Printing and Stationery Office, price 3s.), states that the Grain Elevators Committee has recommended the erection of one elevator at Durban, of 30,000 tons (storage capacity), one at East London of 20,000 tons, and another at Cape Town of 20,000 tons, involving a capital expenditure of 490,000*l.*; also the erection of one "country elevator" at each of 62 inland centres—the size varying according to the tonnage of maize offering at these stations—involving a capital expenditure of 466,000*l.*, or a total outlay of 956,000*l.*

The Industrial Reconstruction Council.—A conference on Women in Industry will be held under the auspices of the Industrial Reconstruction Council on Tuesday, October 22nd, at 6 p.m., in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C. 4. The subject will be introduced by Miss Lilian Dawson, secretary of the Fabian Society Women's Group, after which the discussion will be open. No tickets are necessary.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

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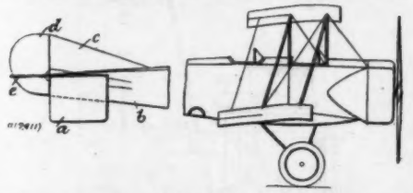
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

AERONAUTICS.

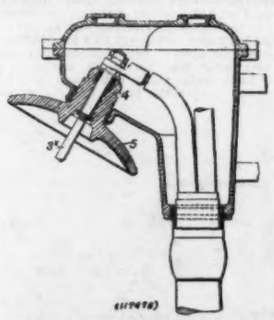
117,411. W. R. D. Shaw, Walthamstow, London. Aircraft. (2 *Figs.*) February 20, 1918.—This invention relates to aeroplanes. According to the invention, the tail plane is given a negative lateral dihedral angle, the arrangement being such that in the event of a side-slip occurring due to excessive banking, a relative downward pressure, that is, a downward pressure relatively to the pressures exerted on other parts of the machine, is exerted on the said tail plane, such as to cause the nose of the machine to be lifted. *a*, *a*, are the two sides or wings of the fixed lateral tail plane or stabiliser, which wings, instead of being in the same plane, as usual, are set so as to incline downwards towards their outer ends, forming between them a negative lateral dihedral angle. The angle at which the two wings of the



tail plane are fixed may be about 45 deg. to the vertical plane of the machine, but this angle may be varied as found most suitable. The wings *a*, *a*, may be stayed to the fuselage *b*. *c* is the vertical fin, *d* the rudder, and *e* the elevator, which latter is mounted independently of the tail plane instead of being hinged thereto as usual, although the latter system is possible also. When banking during turning, should the machine side slip inwards due to the bank being excessive, a nose-dive or spin is prevented by reason of the downward pressure which is exerted on the inclined wings of the negative dihedral tail plane *a*, causing the nose of the machine to lift. Should the machine slip outwards the nose is similarly kept up by the downward pressure exerted on the tail plane. (*Accepted July* 24, 1918.)

ELECTRICAL APPARATUS.

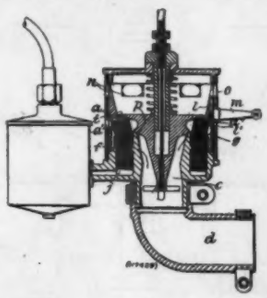
117,478. British Insulated and Helsby Cables, Limited, Prescot, and R. W. Blades, Prescot. Terminal Boxes. (2 *Figs.*) June 20, 1917.—This invention has reference to boxes or apparatus employed in electricity supply systems in which the conductors of a cable are led from the box or apparatus for any electric purpose, and it relates more especially to apparatus where the conductors are led through an insulator in the metal case of the apparatus from which the naked wire emerges and in connection with which weather shields are usually employed. In the present construction, the insulator part 5, which is outside the box, is constructed and adapted to serve both as a weather shield and as an insulator; that is to say, the weather shield portion, which is of insulating material, is in one with or screwed or equivalently fastened on to the part of the said insulator neck 4 which extends through the box, and this weather shield portion or portions has relatively large radius or dimension from



the centre to the periphery, of mushroom, disc or like form, and constitutes an insulator weather shield, so that under wet conditions, a flashing over between the conductors 3x and the earthed metal box and consequent break down, which does frequently take place where the surface of the insulator between the naked conductor and the case is wetted, is avoided. In this box or apparatus, the conductors 3x pass out of the case in a downward and outwardly-inclined direction, and the insulator 5 is extended out to a very considerable radius from the central portion or boss 4 in a mushroom, disc or like form, so that on the underside there is a relatively long length of continuous or unbroken dry surface, and sufficiently long even in wet weather, which lies between the conductor 3x and the wet and upper outside surface of the insulator; and thus the insulator is so formed as in itself to form a weather shield to preserve a long part of surface dry. (*Accepted July* 31, 1918.)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

117,429. The Valveless Two-Stroke Engine Company, Limited, Birmingham, and J. Duffy, Birmingham. Carburettors. (5 *Figs.*) April 19, 1918.—This invention relates to wick carburettors for internal-combustion engines of the type in which the wicks are vertically disposed. A leading feature of the invention is the combination of vertical fuel mixture outlet and a wick, also vertical, surrounding the mixture outlet, and an air supply over the wick to the outlet. *a* is a cylindrical chamber, the bottom part of which is provided with an orifice through which the mixture passes to the engine pipe *d*. Around the upper end of the orifice is a valve seat *e* and around the orifice and valve seat is the wick *f*. The wick is made up of a number of cylindrical wicks which are mounted in a holder *g*. The lower ends of the wicks *f* project into the petrol chamber *j*. The chamber *a* is provided with main air inlet ports a^1 and an air sleeve *l* having a tapered inner surface as shown, is arranged within the chamber and is adapted to be turned about a vertical axis by an arm *m*. The sleeve has main inlet ports l^1 and auxiliary ports *n*; as the sleeve is turned the ports l^1 and *n* register or otherwise with the inlet openings a^1 and *o*. The throttle valve *c* at its upper end is provided with an air-regulating disc *t*, the perimeter of which acts in relation to the taper surface of the air sleeve *l* to regulate the auxiliary air inlet through



ports *n* and *o* automatically as the throttle valve is moved and varied. The lower end of the valve is preferably conical as shown to enable the mixture to follow stream lines as far as possible. In operation, when the engine is running, the air sleeve *l* is fully opened and the operation of the carburettor is practically automatic, as the throttle valve control is used for all speeds. The auxiliary air supply through ports *n*, *o*, may be reduced in the event of a temporary extra load being placed on the engine, when a richer mixture may be required, but for general purposes the throttle valve control is sufficient. The movement of the air sleeve *l* may limit the auxiliary air supply to the engine, but does not regulate it; this is done by the air disc *t*, as the area of the passage between the rim of the air disc and the side of the taper air sleeve *l* varies with the throttle opening. The air disc *t* also acts as an air deflector for sending the air current over the wick when the throttle opening is small, but when the throttle is wide open the auxiliary air current may pass more direct, thus maintaining a constant mixture at all speeds. (*Accepted July* 24, 1918.)

117,348. G. H. Bentley, Westminster, London, and E. G. Appleby, Westminster, London. Gas Generators. (2 *Figs.*) September 20, 1917.—This invention relates to apparatus for feeding fuel to gas generators into which the fuel is fed by means of a rotary drum, which delivers it on to an adjustable cone. According to this invention, the feed drum is fitted with gearing by means of which it can be turned in one direction and then in the other. This may be effected by means of a double ratchet wheel and double pawl. It is found that by intermittently reversing the drive of the feed drum a level surface is maintained in the generator. *a* is an orifice leading to a feed drum of ordinary construction on a shaft *b*, on which are two ratchet wheels *c* and *d*, with one of which, *c*, a pawl *e* is in engagement, whilst another pawl *f*, adapted to engage with the other

Fig. 1.

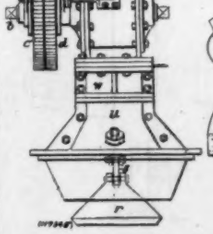
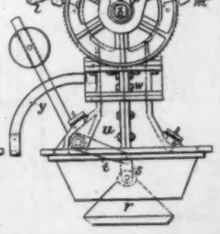


Fig. 2.



ratchet wheel *d*, is turned out of engagement. The two pawls *e* and *f* are mounted upon a common axis *g*, and are turned into and out of engagement by hand and are actuated by means of a rod *h* which may be eccentrically mounted upon a driving shaft. *j* and *k* are cams mounted upon the shaft *b* and actuated by means of rods *l* and *m* respectively and adapted to engage with rollers *n* and *o* on the pawls *e* and *f*, in order to vary the length of time the pawls are in engagement with the ratchet wheels *c* and *d*. The cams are held in the desired positions by screw *p*. Fuel fed into the orifice *a* passes into the feed drum and is discharged on to a cone *r* pivotally connected by a link *s* to an arm *t* carried by a frame *u* secured to the frame *w* supporting the feed drum. Connected to the arm *t* is a weighted lever capable of sliding along a guide *y* in which it is secured in any desired position. (*Accepted July* 24, 1918.)

116,834. G. Green, Strawberry Vale, and F. May, Grove Park, Chiswick. Engine-Starting Apparatus. (5 *Figs.*) November 6, 1917.—This invention relates to engine-starting gear of the kind in which the turning motor on running up to speed is brought into gear with the engine crankshaft by means of a quick-pitch screw and nut. The shaft 1 of the motor 2 has keyed thereon a flange 3 to which is bolted a sleeve-shaped nut 4 of larger diameter. This nut 4 bears internally an operating quick-pitch thread which is engaged by a similar male thread on the shaft 7 which carries the starting pinion 8, the brake drum 9 and the end contact 10. The threaded portion of the shaft 7 is prevented from leaving the nut 4 by means of a flange 11, extending inwardly from a ring screwed on the outside of the said nut 4. Normally, when the whole mechanism is at rest, the male screw remains at the motor end of the nut and draws into the latter the starting pinion 8. When the pinion 8 is in engagement with the large spur wheel 12 on the engine crankshaft, it comes almost into contact with the bearing 13. Next to this bearing the brake drum 9 is keyed. The brake consists of a metal block 16 in one with, and electrically connected to, an insulated hand lever 17. 25 is a collector brush connected electrically to a contact member 24. The shaft 7 is furnished with an end contact 10. The contact member 24 co-acts with the contact member 10, and is electrically insulated from its supporting bracket, but is connected by a lead to the

Fig. 1.

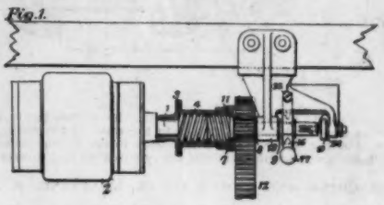
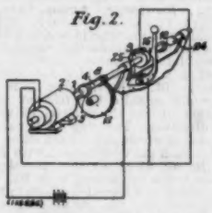


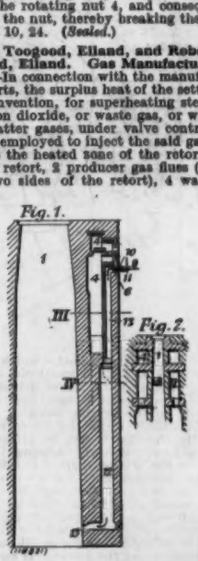
Fig. 2.



hand lever, both being connected to one brush of the motor. The other brush is connected to one terminal of the source of supply, the other terminal of which is earthed. In operation, the lever 17 is operated and closes a circuit through the starting motor but retards the screwed end of the pinion shaft 7. The result is that this latter is quickly thrust outwards by the nut 4. The pinion 8 engages with the main driving wheel 12 and the engine crank-shaft is turned. When the brake lever is released, the circuit through the motor is maintained through the end contacts 10, 24, until the engine fires. Then the engine causes the spur pinion 8 to rotate so quickly that the threaded end of the shaft 7 over-runs the rotating nut 4, and consequently travels to the other end of the nut, thereby breaking the motor circuit at the end contacts 10, 24. (*Sealed.*)

116,831. H. J. Toogood, Eiland, and Robert Dempster and Sons, Limited, Eiland. Gas Manufacture. (4 *Figs.*) October 27, 1917.—In connection with the manufacture of coal-gas in vertical retorts, the surplus heat of the setting is utilised, according to this invention, for superheating steam along with producer gas, carbon dioxide, or waste gas, or with any one or two of the three latter gases, under valve control, the energy of the steam being employed to inject the said gas or gases into a flue opening into the heated zone of the retort. 1 indicates the interior of the retort, 2 producer gas flues (which may be located only on two sides of the retort), 4 waste heat flues,

Fig. 1.

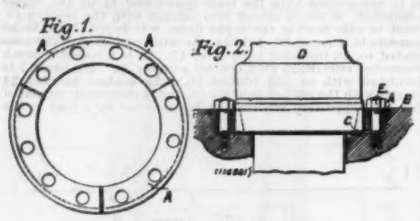


6 a plug closing the steam inlet opening. This plug 6 is pierced with openings through which pass valve-controlled pipes 9, 10, 11. The pipe 9 is in communication with a producer gas flue 2, the pipe 10 in communication with a waste heat flue 4, and the pipe 11 connected to any convenient source of steam. This pipe 11 may discharge alone into the regenerator flue 12, or if either or both of the pipes 9, 10, be opened, the steam passing through the pipe 11 causes it to act as an injector, that is, to draw in gas from one or both of the other pipes. The steam, or steam and gas, after being superheated in the regenerator flue 12, is delivered through the aperture 13 into the retort within the heated zone thereof. (*Sealed.*)

HYDRAULIC MACHINERY.

116,961. Duncan Stewart and Co., Limited, Glasgow, and T. E. Holmes, Glasgow. Hydraulic Presses. (2 *Figs.*) August 7, 1917.—The invention provides improved means for securing columns in the entablatures and bases or platens of hydraulic machines. In carrying out the invention, the column D has formed on it a collar or shoulder C, the plane face of which abuts and is held up against a plane face on the entablature by a nut or nuts screwed upon the ends of the column extending through the entablature. The face on the entablature is formed within a concentric recess B or within a concentric upstanding flange of an internal diameter greater than that of the collar. The periphery of the recess, or if there be an upstanding flange, the internal periphery thereof, is of conical form. There is inserted in the annular space thus formed around the collar or shoulder C, on the column D, a ring *A*, the internal and external faces of which are counterpart to the collar C and recess B.

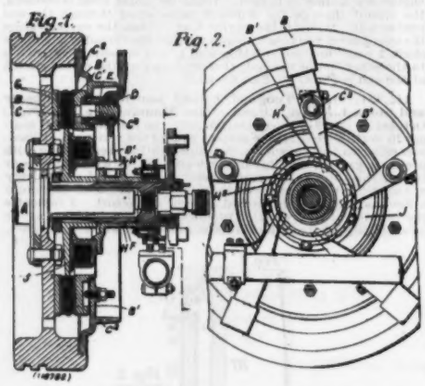
This ring is circumferentially divided into several parts and is secured in position by studs and nuts or screw bolts E passed through it and into the entablature. Upon the column having been drawn into place, the divided ring A is inserted and drawn



up, its wedging action not only centering the column but transmitting all lateral stresses from it to the walls of the recess B or upstanding flange. The whole thus forms a construction particularly well adopted to resist heavy lateral stress. (*Sealed.*)

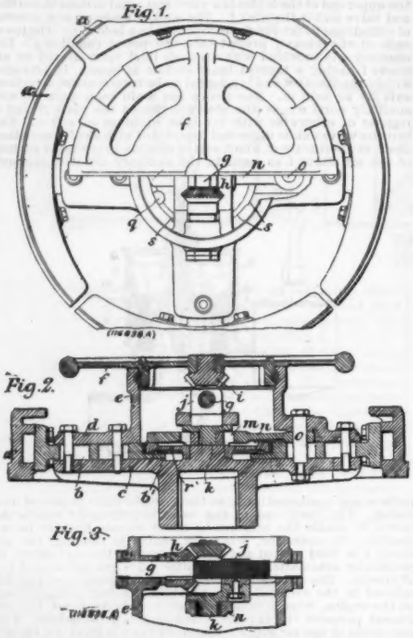
MACHINE AND OTHER TOOLS, SHAFTING, &c.

116,782. D. Napier and Son, Limited, Acton Vale, London, and A. J. Rowledge, Acton Vale, London. Friction Clutches. (3 *Figs.*) July 5, 1917.—This invention relates to friction clutches of the type in which electromagnetic means are employed to bring about the engagement or disengagement of the clutch members. There is mounted on the driving shaft A a disc B which has fixed on it an inwardly-directed flange B1. On the disc B is an annular friction surface C, while opposite this friction annulus is a similar annular friction surface C1 on a ring C2 which can be moved in an axial direction. The ring C2 is carried on the flange B1 by pins C3, each of which can move in either direction in a rotatable sleeve D. Each pin C3 is formed with a quick pitch right-handed screw thread which engages the sleeve D. On each sleeve D is mounted a two-armed lever D1, D2. E is a coiled spring which acts on the lever D1 to rotate the sleeve D in a direction which will move the pin C3 towards the right. As this action takes place on all the pins C3, the ring C2 with its friction surface will thus be moved away from the face of the disc B and the friction surface C. If all the levers D1 are acted on so as to rotate the sleeves D in the other direction, the ring C2 will be caused to move towards the disc B. On the driven shaft F is fixed a disc G, the outer portion of which lies between the friction surfaces C and C1 and carries corresponding friction surfaces G1. Loosely mounted on the driven shaft F is a sleeve H



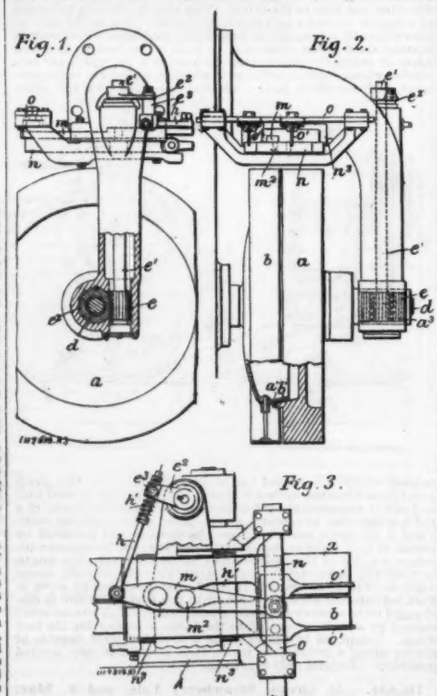
on which is carried an electromagnet J which is directed towards the face of the disc G, and which constitutes an armature for the electromagnet. Pins H2 on the sleeve H bear against the end of levers D1. The arrangement is such that if the sleeve H be rotated relatively to the driving shaft A, movement will be imparted simultaneously to all the levers D1 by the pins H2 and consequently the disc G will be gripped by the friction surfaces C, C1, and the clutch will be engaged. When the clutch is disengaged and the driving shaft A is rotated, the sleeve H, together with the electromagnet J will be carried round on the driven shaft F by reason of the levers D1 bearing against the pins H2. The frictional resistance to rotation of the sleeves and any resultant tendency to impart movement to the levers D1 so as to rotate the sleeves D and engage the clutch is counteracted by the springs E acting on the levers D1 and centrifugal force acting on the parts D2 of the levers. If now while the driven shaft F is either stationary or rotating at a less speed than the driving shaft A, current is caused to flow through the electromagnet J the latter will be attracted to the disc G, and as a result resistance will be offered to the continued rotation of the sleeve H by the driving shaft through the levers D1. The sleeve H will thus be caused to rotate relatively to the driving shaft A, and this will bring about such movement of the levers D1 as will bring about the engagement of the clutch in the manner described. (*Sealed.*)

116,838. The Ajax Engineering Company (Birmingham), Limited, and J. Cox, Birmingham. Machining Annular Objects. (3 *Figs.*) November 12, 1917.—This invention relates to apparatus for gripping or supporting annular members of the type in which a plurality of radially-movable members are adapted to be displaced by a cam, and in which relative movement between the radially-movable members and the cam is imparted by a screw. According to the present invention, in this type of apparatus the screw is adapted to impart said relative movement through the medium of a lever, the axis of which is located eccentrically in relation to the cam and radial members. *a* represent four gripping segments, each of which is mounted upon a slide *b* adapted to slide radially in a frame or body *c*, *d*. The member *d* has an upward tubular extension *e*, in the upper part of which a hand wheel *f* is rotatably mounted. Mounted transversely in the tubular extension *e* is a shaft or spindle *g*, to which a bevel wheel *h* is keyed. This bevel wheel *h* is in mesh with a bevel wheel *i* fixed to the hand wheel *f*. The shaft *g* is externally screw-threaded and upon the screw thread is a nut restrained from rotation; rotation of the shaft *g* imparts an axial movement to the nut *j*. The nut *j* carries a rigid downward projection *k* which engages a bearing block *l* that is adapted to slide in an aperture *m* in a lever *n* pivoted at *o*. The lever *n* co-operates with two projections *q* upon a cam *r* rotatably mounted concentrically with the hand wheel *f*. The cam *r* is furnished with four cam surfaces *s*, one of which is adapted to co-operate with each of the slides *b* so that as the cam *r* is rotated



in an appropriate direction the slides *b* are collectively displaced radially in an equal degree. Each slide *b* has an extension *b1* furnished with a projection which engages with one of a second series of cam surfaces provided on the cam *r*. When the cam rotated in a reverse direction these cam surfaces serve to withdraw the slides *b* and thereby release the work. (*Sealed.*)

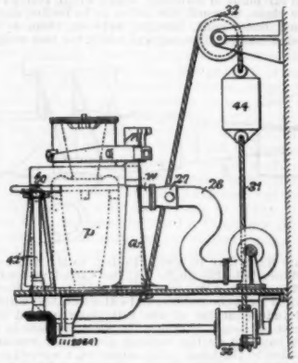
117,315. F. T. Haggas, Keighley, and W. Haggas, Keighley. Planing Machines. (4 *Figs.*) July 21, 1917.—The invention relates to the driving mechanism of planing machines, of that type wherein two driving pulleys are employed, one operating the gearing so as to move the table in one direction, and the other causing said table to move in the opposite direction, while in connection with each of these driving pulleys a loose pulley in the form of a flywheel is employed, the driving belt



being of such width that it may rest wholly on said heavy loose pulley, but does not entirely leave same when moved on to the driving pulley. The type of driving mechanism to which this invention relates is that in which a heavy loose pulley *a* is movable over its shaft or sleeve so that its clutch part *a1* may be moved into engagement with the clutch part *b1* of the fast pulley *b*. In carrying the invention into effect, the pulley *a* is arranged to slide over a sleeve carried by the shaft *d* and is slid over the sleeve by means of another sleeve *d2*, which is provided with rack teeth *a3*. With these rack teeth *a3* gears a pinion *e* fixed upon a shaft *e1*, on which is mounted a lever *e2*, from which extends a connection *e3* to a connecting rod *h* over which extends a spring *h1* in such manner that the movement given by the lever *e2* to said rod *h* is through the spring *h1*. The rod *h* is connected to a lever *m* provided with a downwardly-extending pin *m2* which fits within a cam-shaped slot *m1* in a plate *n*, which latter slides in guides *n3* formed in the framework A. The lever *m* is also connected to the bar *o* upon which are fixed the belt guides *o1*. It will be seen that as the plate *n* slides or is reciprocated in one direction or the other it will move the belt guides *o1* to shift the belt from one position to another and will also cause rotation of the shaft *e1* and movement in one direction or the other of the loose pulley *a*, whereby same is clutched to or relieved from the fast pulley *b*. The slide *n* is actuated by dogs in well-known manner at each reciprocation of the bed of the machine. (*Accepted July 24, 1918.*)

MINING, METALLURGY AND METAL-WORKING.

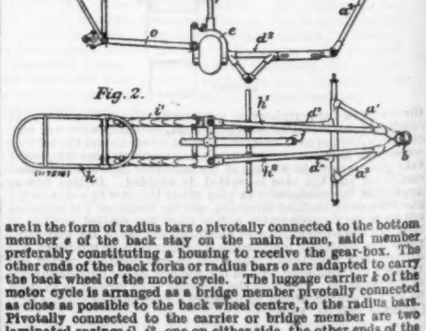
117,054. J. Gaunt, East Finchley, London, D. Brookfield, Holloway, London, and J. Tylor and Sons, Limited, London. Crucible Furnaces. (2 *Figs.*) September 27, 1917.—This invention relates to means for tilting crucible furnaces of the kind in which the air blast is preheated by being conveyed through circuitous conduits formed as an integral part of the furnace before being discharged beneath the grate, and having a preheater for the charge to be melted that is formed as an extension of the cover or closure to the furnace. The connection between the fan or blower is made with a flexible pipe 26 with a convenient union 27 attached to the inlet *w* provided on the body *a* of the furnace. This union is provided to facilitate the detachment of the pipe 26 when it is desired to tilt



the furnace for the purpose of pouring the molten metal therefrom. The crucible *p* is retained in position by refractory blocks, the front one of which is so formed as to provide for the entrance into the spout. The furnace body *a* is provided with trunnions mounted in bearings which form the axis 30 on which the tilting operation is effected. At or near the base of the furnace and at the back thereof is secured the wire rope 31 which passes over the grooved pulley 32 and is then led down over a guide pulley and its opposite end fixed to the winding drum 36 driven through bevel wheels from a vertical spindle 42 that carries the hand wheel 43. The tilting operation is materially facilitated by the interposition of the balance weight 44 in the wire rope or chain 31. (*Sealed.*)

MOTOR ROAD VEHICLES.

117,516. W. Comery, Mapperley Park, Nottingham, and The Rayleigh Cycle Company, Limited, Lenton, Nottingham. Motor-Cycle Frames. (4 *Figs.*) August 3, 1917.—This invention relates to spring frames for motor cycles of the kind comprising two main frames connected at the front to the cycle head. According to the invention, the front and back stays of the frame comprise substantially triangular-shaped members arranged with the apexes at the top, the steering head being attached to the top of the front stay *a1*, *a2*, and connected to the top of the back stay member *f2* by a longitudinal tubular bar *j*. The bottom members of the before-mentioned stays are connected by two longitudinal bars *d1*, *d2*, arranged parallel to each other, and in the same plane, but spaced apart at a convenient distance to receive the power unit. The back forks



are in the form of radius bars *o* pivotally connected to the bottom member *e* of the back stay on the main frame, said member preferably constituting a housing to receive the gear-box. The other ends of the back forks or radius bars *o* are adapted to carry the back wheel of the motor cycle. The luggage carrier *k* of the motor cycle is arranged as a bridge member pivotally connected as close as possible to the back wheel centre, to the radius bars. Pivotally connected to the carrier or bridge member are two laminated springs *i1*, *i2*, one on either side, the other ends of the said springs being connected to the upper part of the back stay members *f2* of the main frame by sockets, in line with two longitudinal bars *k1*, *k2*, connecting the spring sockets direct to the steering head *b* on either side of the frame at a convenient height to support the fuel tank. (*Accepted July 31, 1918.*)